# EDITORIAL

THOSE of us who have yet to experience any return of prosperity may take courage in the fact that the net earnings of the Southern Pacific Company for February show an increase over those for the same month a year ago. This is the first time that such a thing has happened in two years.

UP to March 19 the Alaskan Engineering Commission had received 35,000 applications for employment in connection with the construction of the Government railway in Alaska. When it is added that not one indicated a willingness on the part of the applicant to perform common labor, the entire item may be taken more as an indication of a well known characteristic of human nature than a proof of depressed business conditions.

CHEERING news for street-car officials has been received from Los Angeles. In that city, the birthplace of the 'jitney,' there are now only 700 operating, as against 1200 a short time ago. Failure to accumulate a cash reserve against the inevitable depreciation has doubtless forced many 'jitney' operators to the wall, while the slow but steady revival of business is providing others with more remunerative means of earning a livelihood.

ANNUAL LIST of members of the American Society of Civil Engineers which has just been published shows that California is second only to New York in total number of members, having passed Pennsylvania during the year. The figures for the leading states are as follows: New York, 1790; California, 604; Pennsylvania, 594; Massachusetts, 377; Illinois, 356. In this connection, it is interesting to note that there are 307 members of all grades in San Francisco and the other bay cities, as against 288 in Chicago.

WHEN the United States Steel Corporation was formed in 1901, a basic price for bessemer steel rails of $28 per ton at the mills was established. Until recently no regular sales have been made within the United States, either by the Corporation or by independent mills, at lower figures than these. During the past two months, however, the Algoma Steel Company, a Canadian concern operating near Sault Ste. Marie, has entered the United States market, quoting open-hearth rails at $25 at the mills, or $27.60 at Chicago, and several railroads have made purchases at these figures. The removal of the tariff on steel products, together with the depressed condition of business throughout Canada due to the war, is probably responsible for this condition.

AN interesting experiment is soon to be made in San Bernardino county, California. Bonds for $1,750,000 were voted last fall for a system of improved highways, and the engineering work is now sufficiently advanced to permit commencement of work on about thirty miles of road. Of this amount fifteen miles will soon be let by contract, while the county highway commission has started to construct the other fifteen miles by day labor. A complete outfit of road building machinery and supplies has been purchased by the county and an endeavor has been made to secure the services of competent foremen, already experienced on highway construction under contract. As the work on the highways to be built under the two systems is similar in character, a fairly accurate comparison of the relative cost will be obtained.

BESIDES performing a service to their constituents, the commissioners in charge of the proposed bridge between Portland, Oregon, and Vancouver, Washington, have set an excellent example to all those called upon to award public contracts. When bids for the construction were opened, it was found in the case of the steel for the main span that a local company had bid just $80 higher than the American Bridge Company, the lowest bidder. As may readily be expected, the commissioners were immediately besieged by those who wished the contract awarded to the local concern, but the commissioners insisted on keeping their word and awarded the contract to the lowest responsible bidder. How often has the reverse happened and the outside contractor defrauded, while the credit of the community was impaired by the desire to 'aid' home industry.

FOR some time past the California State Bureau of Mines has been compiling a comprehensive report on the petroleum industry in California. Mr. R. P. McLaughlin has been in direct charge of the work under Mr. F. McN. Hamilton, state mineralogist. This report, designated as *Bulletin* No. 69, has just appeared. A Government publication often loses sight of the fact that an industry, after all, is mainly a matter of dollars and cents. On the other hand, there is grave danger of erring on the other side, and the volume becomes a mere mass of dry and, for the most part, meaningless statistics. The compilers of this report have erred on neither side. While giving due consideration to the geological structure of the various fields, proved and possible, the book deals principally with actual costs of drilling, producing, and transportation, including also a discussion of marketing and refining conditions. Many other im-

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portant subjects are also considered. In fact, little of importance relating to the industry has been omitted. The maps, both geological and civil, are by far the best that have thus far appeared in any publication. The entire report will prove invaluable to the oil men of the state and is a credit to the Bureau and its staff.

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RUMORS of a gigantic oil merger, to include the Union Oil Company, the General Petroleum Company, the California Petroleum Corporation, and the various members of the Independent Producers' Agency, continue to infest the air, but it is safe to say, if any such move is in contemplation, that those engineering the deal will keep exceedingly quiet about it. The outbreak of the war left the relations between the Union Oil Company, the General Petroleum Company, and the Western Ocean Syndicate 'up in the air,' and there they remain. The financial condition of many of the companies included in the proposed merger is such that they would probably welcome almost any method of clearing up the indebtedness outstanding against their potentially valuable properties, but how this is to be done is another question. Meanwhile the work of appraising the properties of the Agency members is proceeding, and it is expected that it will be completed early in June.

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THE contractor on building construction is usually furnished with plans and specifications by the engineer or architect, but he is, as a rule, obliged to figure for himself the quantity of material. When a number of contractors are bidding on the same piece of work, this obviously involves a great deal of wasted effort, which must in the end be paid for by the owner, or by owners in general. In England, the profession of quantity surveyor has sprung up as a result of this condition. The quantity surveyor is a man experienced in estimating and construction, who takes the plans and specifications and prepares a list of quantities, which he guarantees. The usual limit of allowable variation is 3 per cent. The fees range from 1½ to 2½ per cent of the cost of the work, and are paid either directly or indirectly by the owner. In the past few years this system has been introduced in some localities in the United States, and an ordinance has recently been prepared at the suggestion of the Engineers' Club of St. Louis, and passed by the council of that city, governing the practice of quantity surveying. Selections are to be made by the Mayor with the approval of the Council. In England, where the system is well established, the reputation of the quantity surveyor himself is considered a sufficient guarantee of his work, but the St. Louis ordinance provides that the surveyor shall give a bond of $10,000, which is natural in view of the comparative novelty of the entire system in this country. The surveyors are made liable in the courts for damages resulting from inaccuracies in their work. The question of fees is left to private agreement for the present, the idea evidently being to wait until the system has been tried out for a while before fixing a definite scale of fees. Engineers and contractors will watch with interest the working of the new system.

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THE 'affiliated' construction company has been a well-known factor in the development of public utilities and similar corporations. Before the day of 'blue-sky' commissions, it was also one of the most effective devices known for separating a fool from his money. For a board of directors to be able to give a construction contract to another company controlled by themselves opens almost limitless possibilities of wealth for some one. It is doubtful if this method has been used to any great extent in recent years. Certain observers, however, have declared that by letting a contract to an affiliated company at a high price, various public utilities have provided themselves with an abnormally large construction cost as a basis for a request for high rates for service. The California Railroad Commission has recently laid down the principle that in such cases, the two companies shall settle their mutual affairs upon an actual cost and market price basis, before applying for authority for rates based upon supposedly high construction cost.

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IN the case of many public improvements it is inevitable that certain of the property-owners in the vicinity receive more benefit than the public at large. Where this is recognized the usual course is to assess a part or all of the cost of the improvement upon the adjacent property-owners, generally in proportion to the assumed benefits derived. Another method which has been proposed frequently in recent years, but which has seldom been put in practice, is that the governing body acquire at least part of the land to be benefited and profit by the expected increase in values. As an example of this procedure, an interesting scheme for raising funds for the maintenence of the many miles of hard-surfaced roads proposed or now under construction throughout the country has been suggested by Mr. T. C. du Pont, powder manufacturer, who is now building, at his own expense, a permanent highway across Delaware. He proposes that when the right-of-way for an improved highway is being acquired, an additional strip of land 200 feet wide be obtained where possible. By making the location of the road in that particular section conditional upon the acquirement of at least a large percentage of this additional right-of-way, he believes that most property-owners would be persuaded to give this land or at least deed it for a low figure. In renting this abutting land, the leases are to be arranged to safeguard the lessee in making improvements, but provide for an occasional re-valuation of the land itself. Thus it is believed that a sufficient amount could be raised to provide for the maintenance of the highway. By tabulating the rise of land values in areas adjacent to some improved road which has been built, and properly maintained, for several years, a fairly clear conception of the practicability of the entire scheme may be obtained.

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# REVIEW OF THE MONTH

THE Panama-Pacific Exposition continues to be the centre of interest, the total attendance for the first thirty days exceeding 2,000,000. There are many exhibits from European nations in spite of the war, and more are expected. Such losses as have been sustained due to this cause have been amply compensated by the activities, Governmental and private, of the United States and other countries at peace. The Exposition in general has been officially opened by the Vice-President of the United States, whose keen wit and brilliant satire have charmed his listeners.

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THE first of many conventions of engineering interest to assemble this year at San Francisco was that of the Inland Waterways Association of California, which took place at the civic auditorium on March 23, 24, and 25. This Association was formed in January of 1914 and now numbers over one thousand members in various parts of the state. It was decided to hold a joint convention with the International Irrigation Congress, which meets at Fresno next September, and that the regular semi-annual meeting will convene at Los Angeles immediately thereafter.

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THE act of the convention having the greatest general interest was a resolution urging the passage of a bill now before the California legislature providing for the creation of a waterways commission. While there is no question that the waterways of California need more consideration and supervision than they have been getting, still it would appear that better results would be obtained by enlarging the duties of the newly organized State Water Commission than by the appointment of an additional body. In California particularly, questions of irrigation, drainage, and power development are indissolubly connected with those of navigation, and it would seem more desirable to have all these questions adjudicated by one body.

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THE Sutter by-pass is another topic that engaged the attention of the convention. Our readers will recall an article on this subject in the issue for October 1913, based upon the reports of Messrs. George N. Randle and Edward F. Haas. The channel of the Sacramento river, through most of its course through the valley, has proved wholly inadequate to carry the excess run-off during flood seasons. Engineers representing the Federal Government have reported in favor of constructing by-passes for handling the flood-waters at several points along the river. One by-pass is to extend from a point near Meridian to the junction of the Sacramento with the American river. Thus far nearly all those interested are in accord. But the original Government project, which was not based on detailed surveys, provided for placing the by-pass in the trough of the so-called Sutter basin. Surveys by the State Reclamation Board seemed to indicate that placing the by-pass somewhat farther east, on higher ground but on a more uniform grade, would be desirable, and a report in favor of this location was adopted by a divided vote. The decision of the Board was in agreement with the opinions of a number of prominent engineers who have studied the situation at different times, among them Mr. C. E. Grunsky of San Francisco, who reported in favor of a similar project some years ago. On the other hand, many of the farmers and other residents of Sutter and Yuba counties believe that the adoption of the eastern location would endanger their lands, and they have protested against a number of bills now before the legislature which favor this location. The situation is complicated by the fact that a syndicate of Eastern capitalists now developing land in the Sutter basin would be greatly benefited by the eastern by-pass.

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LOS ANGELES aqueduct has been given a clean bill of health by Judge Lewis R. Works, who has decided that the water supplied is fit for human consumption and that it is unnecessary for the city to obtain a permit from the State Board of Health for the use of the water. This, presumably, disposes of the question so far as the law is concerned, and the city cannot now be prevented from using the aqueduct water to its heart's content. However, disinterested well-wishers both of the city itself and of the eminent engineers who have labored so faithfully for the success of the entire project will wish, now that all legal obligation is removed, that the entire question of the potability of the water might be referred to the State Board of Health, or better still, to some other body of authorities absolutely removed from any suspicion of partiality toward any of the contestants in the fray.

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THE long-expected receivership for the Western Pacific railroad has arrived. The Denver & Rio Grande railroad, having defaulted on its guaranty, the interest due on March 1 remains unpaid. Proceedings have been instituted for a receivership and the Court has appointed Messrs. Warren Olney and Frank G. Drum in this capacity. The road is said to have cost approximately $60,000,000, and has a bonded debt of $75,000,000, of which $50,000,000 is in 5 per

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cent first-mortgage bonds held by the general public, and the remainder is in second-mortgage bonds held by the Denver & Rio Grande. Since being opened for traffic in 1911, the road has regularly failed to earn enough to meet the interest on its first-mortgage bonds, and the Denver & Rio Grande has been called upon every six months to make up the deficit. What effect its recent refusal to carry the burden any longer will have upon the status of the Denver & Rio Grande remains to be seen, but it seems possible that there will be a receivership for that road also.

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FROM the standpoint of the operating department, the qualifications of the Western Pacific leave little to be desired. With easier grades and a lower summit, it is apparently well equipped to compete with the other railroads entering California from the east. Even the difficulties arising every winter from slides in the Feather River cañon will lessen as the roadbed becomes more settled. But the road runs through a sparsely settled country for almost the entire distance, has no feeder lines in California, and has inferior connections at Salt Lake City. It is not surprising, therefore, that last year the road earned less than 1 per cent on its bonded indebtedness.

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WHAT gives the whole question more general interest than usually attaches to the troubles of a bankrupt railroad is the proposal that either the Federal Government or the state of California acquire control of the road. Of these, the second alternative is most in the public eye and has received sufficient support in various quarters to render it inadvisable to regard the matter any longer as a joke. Disregarding the general question of the advisability of Government ownership of railroads, and the, as yet, undetermined one of the constitutionality of a state owning an interstate road, it is doubtful whether the state would find the road to be worth what it would be obliged to pay for it. In the purchase the state would acquire nothing that the present owners do not possess. It is probable, also, that it would not be able to obtain one thing which the present owners have, namely, a connection, even though it is a poor one, with the East. There is general agreement among railroad men that the only possible chance to make the Western Pacific a paying road is to build feeder lines and provide improved connections. The first would require a large additional expenditure, probably without returns for several years. Whether the railroads running east from Salt Lake City would be willing to enter into any traffic arrangements which might contribute to the success of a Government-owned road is, to say the least, doubtful. There are several existing roads that might find the Western Pacific a good investment at the comparatively low price that the bondholders may be obliged to accept, but if either the Federal Government or the state of California wish to make a trial of Government ownership of an ordinary American railroad, there are many better ways to do so than by the purchase of the Western Pacific.

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A PROJECT similar to the one for the purchase of the Western Pacific is a resolution introduced at Sacramento looking toward a state-owned system of electric railroads. The State Highway Commission is asked to investigate and report upon the cost of acquiring a number of existing interurban electric railroads and of building additional lines following the state highways. While this project resembles the Western Pacific scheme in calling for a large expenditure of public money without immediate return, there are some attractive features about it. It is well known that there are several interurban lines in various parts of the state that are finding it difficult to weather the development years, but which will ultimately repay the cost of their construction. There are other localities where an electric line would be an immediate blessing and an ultimate good investment, but which are not attractive to private enterprise. It is hardly likely, however, that any general system following the state highways would pay either in dollars or in general benefits to the community. These highways are, as a rule, adjacent and nearly parallel to existing railroads, which are, in general, able to take care of the needs of the communities which they serve. Indeed it is doubtful whether the Railroad Commission would be justified in issuing a certificate of necessity and convenience to such state-controlled roads.

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THE Bureau of Mines is a small and comparatively inexpensive department of the Federal Government. The cost of one battleship would run it for a great many years. Nevertheless, besides a large amount of general work which is none the less important because few persons ever hear of it, the Bureau once in a while comes out with a revolutionary discovery. Dr. Walter F. Rittman, chemist for the Bureau, has discovered a process whereby the amount of gasoline obtained from heavy oils may be increased, and also a process for obtaining benzol and toluol, important components of dyestuffs and of modern explosives, from crude oil. These products have hitherto been obtained from coal-tar alone. Applications have been made for patents on both of these processes, with the idea of reserving them for the benefit of the public at large. It is still too early to state definitely whether the cost of production of gasoline can be reduced by the use of this process, but it is certain that it can be made in greater quantities and from cheaper crude products than heretofore. An agreement has been entered into between the Bureau and the Aetna Explosives Company, of New York, under which the Company agrees to expend not less than $200,000 in the construction of apparatus and machinery for the development of the process for making benzol and toluol. Similar negotiations are under way with another company for development of the gasoline process.

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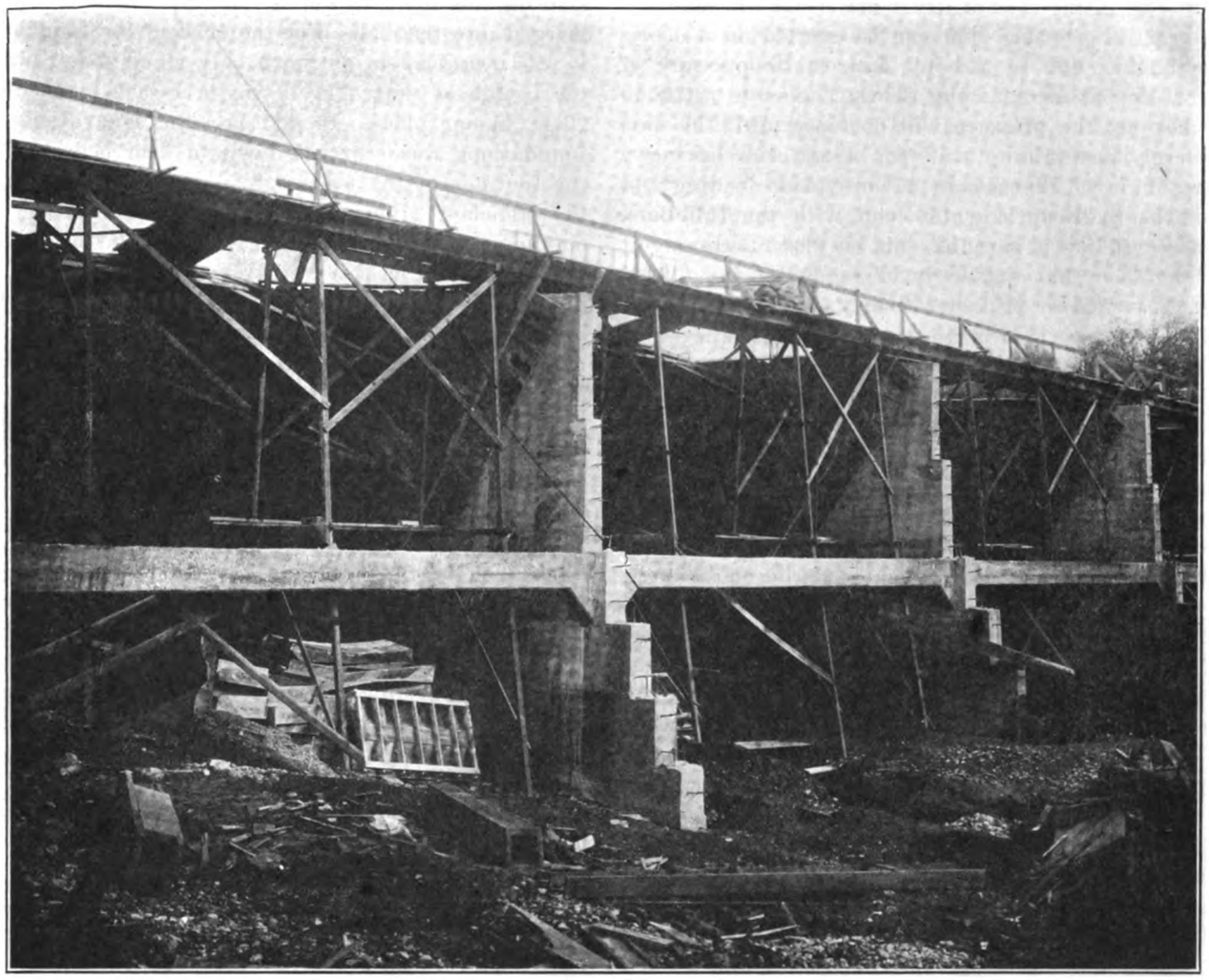

# The Kennedy Dam

By JOHN S. EASTWOOD*

Dams are used for a greater variety of purposes than most people think. Each of the multiple-arched dams designed and built by the writer to date has been intended for a different service. The Hume Lake dam was built for the storage of water for transporting lumber in a flume and as a logging pond for the storage of logs for the sawmills of the Hume-Bennett Lumber Co. at Hume, Fresno county, California. The new Big Bear Valley dam was built to store the excess waters for a series of years, from the drainage area of Bear creek, as a reserve supply for the intensive irrigation of the citrus groves of Redlands and vicinity. Incidentally, the water is used also for power, on its way from the reservoir to the distribution system.

The Los Verjels dam is used to store the annual winter flood-waters of Dry creek, a branch of the Yuba river, in Butte county, California, for the irrigation of the olive lands of the Los Verjels Land & Water Co. The Kennedy dam, described in this article, is used for storing the tailing from the quartz mill of the Kennedy Mining & Milling Co., near Jackson, Amador county, California. Thus, of four dams of the multiple-arched type, now in service, one is used for log and water storage, one for cyclic irrigation water storage, one for seasonal irrigation water storage, and the last for the storage of quartz-mill tailing. The structure erected for the Kennedy company is a multiple-arched dam, especially designed to meet the conditions at the site selected and for the purpose of storing tailing. The computations of loads and stresses are based on the assumption of a liquid loading with a liquid having a weight of 75 lb. per cubic foot. The tailing, when thin enough to exert complete hydrostatic pressure, will not weigh this much, and before it reaches this weight per cubic foot will have become so viscous that it will exert a pressure limited by the angle of repose that it will

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assume as in the case of dryer materials. Practically, the greatest pressure that can be exerted on a débris dam is that due to the full hydrostatic pressure of water; for as soon as the débris begins to settle to the bottom, the pressure will decrease until the dam is merely a retaining wall for a material having a large angle of repose and a consequent loading less than the hydrostatic water load with the full dam. This seems like a paradox, but on closer scanning it will be seen that the angle of repose of the fill increases as fast as or faster than its weight.

The structure is situated about one-half mile north of the town of Jackson, on the property of the Kennedy Mining & Milling Co., and closes the lower end of a small valley. The dam is 30 ft. high from the ground surface, and forms the base of a structure to be eventually built to a height of 50 ft. The storage capacity on the basis of the horizontal contour space enclosed, is 15,804,164 cu. ft., up to the 50-ft. contour, but as the sand and coarser materials lie on an angle of repose varying with their size of particle, usually above 20° from the horizontal, the actual capacity is much greater than this, as the flume carrying the slimes from the lifting wheels enters the upper end of the valley at an elevation considerably above the 50-ft. contour, and it is therefore possible to utilize the slopes of the valley for disposing of a large amount of the coarser sands. The drainage area of the whole valley is but 0.13 square mile, and the rainfall not excessive, requiring a very small spillway capacity at the dam.

The dam is 455 ft. long on the crest, and consists of 11 arches and 12 supporting buttresses, and a small spillway having a 15-ft. opening, placed at the west end of the structure. The span from centre to centre of buttresses is 40 ft.; the slope of the water face is 10 horizontal to 12 vertical; the slope of the back edges of the buttresses, which are stepped to make the connections for future extension, averages ½ to 1; the angle of arc of the extrados of the arches is 133° 34′; the radius of the extrados of the arches is 21.8 ft.; the radius of the intrados is varied to give the required thickness of arch ring. The minimum thickness of the arches is 1 ft. at the top, and of the buttresses the same. The buttresses are supported laterally by means of a strut tie beam running through from end to end and terminating in a counterfort, thus making the buttresses the equivalent of short columns and preventing any lateral vibration. The spillway is situated at the west end of the dam so as to deliver the water to the most convenient point for use for irrigation, and is 15 ft. wide and 2 ft. deep, being provided with flashboards to regulate the flow of the water and to carry it up to the top of the dam.

The 'country rock,' as it is termed by the mining fraternity, is a laminated slate, pitching toward the east at a steep angle, and striking almost across the axis of the dam. This bedrock is overlaid with a clay to depths varying from 4 to 20 ft., merging into sound slate as the depth increases, the upper portions being merged into the clay. For the most of the foundation it was necessary to go down only about 6 ft.; but in the trough of the valley it was necessary to go down 20 ft. in one place. In all cases the excavations for foundations were carried down to firm bedrock and the footings of the walls spread to the full width of the trenches, giving a very light base loading, the maximum in any case being less than 5 tons per square foot. As the arch is a free arch, that is to say, three-hinged, all of the load is assumed to be carried on the buttress bases. The toe or base of the arch rings is placed in a tapered trench excavated in the bedrock and the trench filled up to the rock surface without forms, making a cut-off wall, the wall above the bedrock surface being allowed to spread over the top of the rock on the upstream side, the forms meeting the trench on the downstream side.

Wooden forms were used throughout except for the hinge sockets, those for the buttresses being made in panels, using inch boards nailed on 2 by 4 studs framed, the panels being three kinds, angle panels for the buttress fronts, full panels for the main walls, and half panels for finishing the rear ends of the buttresses. The full panels were 4.8 by 8 ft., the angle panels and half panels being 4 ft. long, all so planned as to permit of their being fastened to the next by means of dowel pins of wood, and the panels so arranged as to break joints with each other.

The front edges of the buttresses are made in the form of a corbel, the corbel containing the spring line hinge socket of the arch ring, which was cast by means of a metal form, rolled to the true curvature, the remaining parts of the corbel forms being made of wood. The forms for the intrados of the arch rings were made of wood, following the original method used in other dams of this type, these consisting of liners built up of inch boards with 2 by 4 studs nailed between, the whole being covered by ½ by 6-in. boards nailed to the studs and lapped.

The forms for the extrados of the arches consist of panels of such a size that four make up the segment of the exposed arc, the panels being of liners of 1-in. boards cut to the curvature, with narrow boards nailed across, all panels being so designed as to be fastened to each other by means of dowel pins through the frames.

By the use of a three-hinged arch, all bending in the arch ring is eliminated, but in order to prevent the possibility of cracks in the arch rings, old cables were used for reinforcing the arch ring segments. These are placed on the line normal to the arch crown line and wired in place one foot apart, being cut to a length to suit the segment. At the spring line hinge socket in the corbel a hooping effect was obtained by placing ½-in. twisted rods at a depth of 4 in. below the surface running around the entire corbel and into the buttresses. Short pieces of ¾-in. twisted steel are inserted in the stepped back of the buttresses to tie

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them to the extension when made, at the time of adding the remaining 20 ft. of top for which the design provides. The strut tie beams are reinforced as continuous beams with five old hoist cables, 1¼ in. diameter, these running the full length of the beam and into the counterfort at the end of the beams. All cables were left with their grease coating intact and were wired in place.

The concrete was specified to be of a mix of 1:2:4 for the arch rings and of a 1:2½:5 for the buttresses, but in fact was richer than this in all cases. The aggregate was obtained from the old placer diggings in the upper end of the valley, and is made up of irregular fragments of quartz rock of varying sizes intermixed with slate fragments. In its natural state it was so dirty that it was necessary to wash it before using. A gravel washer was installed, and all of the gravel and sand washed and screened before being used.

The gravel from the pit was hauled into a stockpile and was scraped into the boot of a bucket elevator by which it was hoisted to the top of the washer tank and dumped into the water, being forced slowly up an inclined wooden tank through the water and finally delivered into the end of a conical screen through a spout, the fine material dropping into a bin under the screen and the coarse into a separate bin. Water was forced through the end bearing into the tank, and also through perforated pipes lying alongside the screw. This type of washer did not work well with the irregular coarse aggregate, as it would jam under the screw and stop it, requiring a lot of work to find and remove the offending piece, which was usually a flat spall that got under the blade of a screw flight. The separated aggregates were measured in chutes in the proper proportions from the bins and mixed in a Lansing mixer, operated by a gas-engine. From the mixer the concrete was conveyed to the forms in concrete buggies and deposited through homemade portable chutes.

The buttresses were carried up first and finished to the full height, after which the arch rings were poured, keeping them all at about the same level. The arch rings were poured in alternate halves for a small height, using a part of the corbel hinge form for the crown hinge form, which was slipped up about half its length on a line and the concrete laid against the finished part. The metal forms used for the hinge sockets made smooth work except that an occasional small stone pocket would occur, in which case the holes would be filled with mortar, screened smooth and troweled, and when dry a coating of asphaltum was applied to the surface with a flat brush and the excess removed by using a hot hand roller for burnishing the surface. When finished, an even and polished surface of asphaltum was shown, this being the form against which the arch ring was cast. Care was used not to abrade this surface, the concrete being tamped against it by means of puddling with sticks. The finish of the sockets was carried on only a short way ahead of the concrete so that it would be uniform.

The dimensions and stresses in this design were carefully checked, and the plans for the dam approved by Col. W. H. Heuer, U.S.A., engineer, retired, consulting engineer, Pacific building, San Francisco. The approval of this type for storage of débris was only given after a very thorough analysis of the stresses in the design and the suitability of this type of structure for the purpose. The multiple-arched dam is the ideal dam for débris storage for the reason that it is at once the cheapest as well as the strongest permanent dam that it is possible to devise. Cost plays such a prominent part in the problem that it is almost always the determining factor; for upon cost depends the possibility of the development of a project with profit. There are many hydraulic mining properties in California that are tied up on account of the cost of the storage of the débris, using the type of archaic dam specified by the authorities in charge. The difference in the cost of the types of dams means the difference between the possibility of development and the abandonment of the project for all time.

An interesting comparison of the ratio of quantity and cost of the Kennedy dam and the Wegmann practical profile No. 1 (see Wegmann's Dams, Plate XIV) can be made. The Kennedy dam contains 1233 cu. yd. of concrete; a standard Wegmann dam for the same opening would contain 8540 cu. yd., or a ratio of 1 to 6.93. Assuming the ratio of unit cost to be $12 to $19, or as 1 to 1.59 in favor of the solid dam, the ratio of cost, in favor of the multiple-arched dam is 1 to 3.99. In addition to this the multiple-arched dam has as a least safety factor that of the greatest in the solid dam, this least safety factor being four times as great as the least in the solid dam, making it four times as strong in its weakest part. It eliminates the up-thrust under the base, gives an absolutely balanced base loading, and entire stability.

Work was commenced on the dam, June 10, 1914, and the structure was completed December 1, 1914. The work was done by the Eastwood Construction Co. on the basis of cost plus a fixed sum for engineering and superintendence. The opening in the base of the dam was closed on December 4, 1914, and the pond was full of water up to within 10 ft. of the top on December 17, 1914.

SUMMARY OF DATA

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|---|---|
| Length of crest | 455 ft. |
| Height above surface | 30 ft. |
| Height above foundations | 43.8 ft. |
| Length of spans | 40 ft. |
| Number of buttresses | 11 |
| Number of arches | 12 |
| Arc of extrados | 133°34′ |
| Radius of extrados | 21.8 ft. |
| Maximum loading | 18.85 tons per sq. ft. |
| Minimum safety factor | 10 |
| Base loading on buttresses | 5 tons per sq. ft. |
| Cubic yards of concrete | 1233 |
| Ratio of cost to that of solid dam | 25.2% or as 1 to 3.99 |
| Ratio of yardage to that of solid dam | 1 to 6.92 |

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# Concrete Sewer Pipe

By LEWIS R. FERGUSON*

In 1872, concrete pipe was used in the sewers of Allegheny, Pennsylvania, and as long ago as 1861 the city of Brooklyn, New York, built sewers of concrete pipe. In the latter city they now have upward of 500 miles of sewers of this type. Paris and Vienna have long used concrete sewer pipes. In fact these cities use practically no other type of construction. The city of Baltimore has during the past few years, in connection with its extensive sewer system, installed a large amount of concrete sewer pipe.

It is interesting to note some of the Baltimore prices. For example, on contract No. 22, for furnishing material and building a 36-in. circular sewer of brick masonry the price bid was $4.25 per lin. ft.; for ordinary concrete, $3.50; and for reinforced concrete, $3.25. On the same contract the price bid for 33-in. circular sewer of brick masonry was $3.75; for monolithic concrete, $3.50; and for reinforced concrete, $2.55. Again, on the same contract, for a 30-in. circular sewer of brick the bid was $2.90; of concrete, $2.50; of reinforced concrete, $2.20; while the price bid for furnishing and laying 30-in. vitrified pipe was $3.25.

These prices show the economy in first cost that may be effected by the use of concrete pipe. This advantage is one among many advantages possessed by concrete sewer pipe. In many sections of the country, concrete pipe must compete with terra cotta. Here, again, reinforced concrete pipe possesses many distinct advantages. The reinforcement and wall thickness in concrete pipe can be made sufficiently strong to resist practically any earth pressure. Concrete pipe, if properly made, does not have to be maintained, and cement possesses the quality of increasing in strength with age. The possibility of molding concrete pipe to any shape desired is a great advantage, and equally important is the fact that concrete pipe can be made perfectly true, which permits the building of a sewer with joints that are absolutely flush and true on the inside. There is no warping or twisting of the concrete pipe during the process of curing, and when laid the sewer certainly offers a considerably less frictional resistance to materials passing through it than do sewers built of pipes of irregular shape.

Philadelphia has, during the past year, been carefully investigating the merits of concrete pipe for sewer construction. As a result of this investigation an experimental line was built. It is impossible to obtain figures which would give exactly the relative cost of the Philadelphia reinforced concrete pipe with other types of sewer construction, but such an estimate may be closely approximated. At almost the same time that prices were obtained on the concrete pipe, bids were asked for on a brick sewer in the same locality in which the pipe was laid, and under almost identical conditions. The price of a 36-in. brick sewer was $7.95, of a 3 by 2-ft. egg-shaped brick, $4.35. This latter price, however, was for a single ring sewer. This type of construction the city engineer for Philadelphia did not consider at all satisfactory, owing to the excessive infiltration. Compared with these prices the cost of the concrete pipe is very favorable. For a 36-in. circular concrete pipe the price of $5.10 was given, while for a 3 by 2-ft. egg-shaped reinforced concrete pipe a price of $4.72 was bid.

This question of infiltration is a most interesting one, and at a meeting of the American Society of Civil Engineers a few years ago the subject received a great amount of consideration. The reinforced concrete pipe proved satisfactory in resisting infiltration. Owing to the imperviousness of the pipe walls and the closeness with which the joints can be made, infiltration can be made negligible, and a sewer may be designed without considering the necessity of taking care of any of the ground-water.

One often hears that concrete pipe, if suitable for sewers at all, can only be used for storm sewers. It has been very frequently suggested that the acids from sewage will rapidly disintegrate concrete pipe. I believe this to be very largely a myth. In this day when increased efficiency is the slogan of practically every manufacturing establishment, it is not customary to allow valuable by-products to be wasted and run into sewers. Paper mills and other factories using acids are not throwing away concentrated solutions of this very valuable material. As far as the action of sulphuretted hydrogen from ordinary sewage is concerned, it has been claimed that a deteriorating effect occurs above the flow line. The many concrete monolithic sewers which have proved satisfactory after years of use show no deterioration and they refute this claim. As far as the action below the flow line is concerned, this is simply a question of wear caused by friction, and the concrete in reinforced concrete pipe is no different from the concrete in monolithic sewer. Without doubt there is an enormous field opening up for concrete sewer pipe. In the eastern section of the country, where it comes in competition with pipes of other material, even though brick and terra cotta can be readily obtained, the concrete pipe is overcoming opposition and is securing attention not only through its intrinsic merits, but also on the question of price. In the far West, where shipments of terra cotta pipe made over long distances, involve breakage and high freight rates, and where deep ditches are often necessary, thus producing an overload which terra cotta pipe is unable to sustain, concrete pipe should have the field to itself.

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# Cost Data on Construction of Columbia Highway

The building of the Columbia highway up the Columbia river from Portland, Oregon, called for an unusually large amount of heavy construction. The work was done by day labor during the season of 1914, under the direction of John B. Yeon, roadmaster of Multnomah county. The accompanying summary of cost data is taken from the first annual report of state highway engineer Bowlby.

The following scale of wages was in force for an eight-hour day:

| | |
|---|---|
| General foreman | $150.00 per month and board |
| Timekeeper | 75.00 per month and board |
| Foreman | $3 to 3.50 per day |
| Laborers | 2.25 per day |
| Wall mason | 2.75 per day |
| Team with driver | 5.00 per day |
| Board | 5.25 per week |

| | Camp 3 | Camp 2 | Camp 4 | Camp 1 | Camp 5 | Total |
|---|---|---|---|---|---|---|
| *Grading—* | | | | | | |
| Station to station | 20-96 | 96-219 | 219-372 | 372-438<br>122-384 | 384-530 | |
| Mileage | 1.47 | 2.32 | 2.91 | 6.20 | 2.76 | 15.66 |
| Labor and explosives | $ 44,966.83 | $ 33,611.41 | $ 34,052.63 | $ 52,992.36 | $ 12,279.76 | |
| Tools and rentals | 1,826.13 | 5,258.22 | 5,612.12 | 5,262.29 | 2,010.10 | |
| Proportion overhead charges | 2,337.98 | 2,051.45 | 1,691.28 | 2,232.32 | 762.78 | |
| Total cost | $ 49,130.94 | $ 40,921.58 | $ 41,356.03 | $ 60,486.97 | $ 15,052.64 | $206,948.16 |
| Common excavation, cubic yards | 26,356 | 73,829 | 4,439 | 19,100 | 8,449 | 132,173 |
| Per cent of total | 22.8% | 72.9% | 5.6% | 20.0% | 31.8% | 31.7% |
| Loose rock, cubic yards | 6,157 | 19,241 | 59,643 | 57,298 | 7,322 | 149,661 |
| Per cent of total | 5.5% | 18.9% | 76.4% | 60.0% | 27.6% | 35.9% |
| Soft rock | 51,025 | 650 | | | | 51,675 |
| Per cent of total | 44.1% | 0.6% | | | | 12.4% |
| Hard rock | 31,882 | 7,626 | 14,022 | 19,100 | 10,746 | 83,376 |
| Per cent of total | 27.6% | 7.6% | 18.0% | 20.0% | 40.6% | 20.0% |
| Total excavation, cubic yards | 115,420 | 101,346 | 78,104 | 95,498 | 26,517 | 416,885 |
| Overhaul, cubic yards, 100 feet | 2,663 | 810 | 20,992 | 98,575 | | 123,040 |
| Cost per cubic yard | $0.426 | $0.404 | $0.527 | $0.634 | $0.568 | $0.496 |
| Cost per mile | $ 33,422.41 | $ 17,638.61 | $ 14,211.69 | $ 9,755.96 | $ 5,453.86 | $ 13,215.08 |
| *Clearing and Grubbing—* | | | | | | |
| Station to station | 20-96 | 96-210 | 210-394 | 394-438<br>122-300 | 300-530 | |
| Mileage | 1.47 | 2.16 | 3.48 | 4.20 | 4.35 | 15.66 |
| Labor and explosives | $ 2,102.15 | $ 4,438.96 | $ 4,308.45 | $ 4,875.07 | $ 1,753.29 | $ 17,477.92 |
| Proportion of overhead charges | 88.78 | 233.92 | 183.66 | 187.27 | 173.88 | 867.51 |
| Total cost | $ 2,190.93 | $ 4,672.88 | $ 4,492.11 | $ 5,062.34 | $ 1,927.17 | $ 18,345.43 |
| Clearing acres | 8.7 | 14.5 | 22.3 | 22.4 | 16.0 | 83.9 |
| Grubbing, square yards | 339 | 702 | 1198 | | | |
| Cost per acre, clearing and grubbing | $ 251.83 | $ 322.25 | $ 214.39 | $ 225.19 | $ 120.45 | $ 218.66 |
| *Dry Rock Retaining Walls—* | | | | | | |
| Station to station | 20-96 | 96-219 | 219-372 | 372-438<br>122-384 | 384-530 | |
| Mileage of road constructed | 1.47 | 2.32 | 2.91 | 6.20 | 2.76 | 15.66 |
| Excavation for foundation | $ 1,025.49 | $ 1,208.44 | $ 1,756.16 | } | | |
| Hauling and quarrying | 1,105.14 | 1,669.83 | 4,606.66 | } 29,250.85 | | $ 54,384.50 |
| Construction | 5,398.45 | 2,607.59 | 5,755.89 | } | | |
| Proportion of overhead charges | 443.91 | 290.17 | 553.71 | 1,119.91 | | 2,407.70 |
| Total | $ 7,972.99 | $ 5,776.03 | $ 12,672.42 | $ 30,370.76 | | $ 56,792.20 |
| Surface yards wall | 1,384 | 1,661 | 2,239 | 9,428 | | 14,712 |
| Cost per square yard | $5.76 | $3.48 | $5.66 | $3.22 | | $3.86 |
| *Parapet Walls—* | | | | | | |
| Rock with reinforced concrete top: | | | | | | |
| Lineal feet | 444 | | 558 | | | 1,002 |
| Cost | $ 1,217.97 | | $ 1,149.52 | | | $ 2,367.49 |
| Cost per lineal foot | 2.75 | | 2.06 | | | 2.36 |
| *Culverts and Drainage Ditches—* | | | | | | |
| Ditches | $ 727.70 | $ 1,062.67 | $ 269.01 | $ 737.85 | | $ 2,797.23 |
| Corrugated iron pipes: | | | | | | |
| Material | $ 771.29 | $ 4,626.16 | $ 1,632.98 | $ 649.54 | $ 941.28 | |
| Labor | 241.47 | 1,349.56 | | | 131.11 | |
| Total | $ 1,012.76 | $ 5,975.72 | $ 1,632.98 | $ 649.54 | $ 1,072.39 | $ 10,343.39 |
| Rock culverts with concrete slab top: | | | | | | |
| Excavation | | | $ 249.73 | | $ 1,027.15 | |
| Quarry and hauling rock | | | 742.13 | 3,166.17 | 664.84 | |
| Construction culvert walls | | | | | 2,528.97 | |
| Concrete top | | | 1,626.87 | 1,570.73 | 945.31 | |
| Totals | | | $ 2,618.73 | $ 4,736.90 | $ 5,166.27 | $ 12,521.90 |
| Ditches, pipe and rock culverts | $ 1,740.46 | $ 7,038.39 | $ 4,520.72 | $ 6,124.29 | $ 6,238.66 | $ 25,662.52 |
| Overhead charges | 88.78 | 373.08 | 191.88 | 206.01 | 332.52 | 1,192.27 |
| Total cost | $ 1,829.24 | $ 7,411.47 | $ 4,712.60 | $ 6,330.30 | $ 6,571.18 | $ 26,854.79 |
| Corrugated pipe: 8" | | 128 | | | | 128 |
| 10" | | 244 | | | | 244 |
| 12" | 354 | 842 | 246 | 28 | 278 | 1,748 |
| 15" | | 80 | 130 | | | 210 |
| 18" | 110 | 282 | 228 | 170 | 182 | 972 |
| 24" | | 382 | 176 | 132 | 98 | 788 |
| 30" | 96 | 358 | 160 | 24 | | 638 |
| 36" | | 296 | | | | 290 |
| Total lineal feet of pipe | 560 | 2,606 | 940 | 354 | 558 | 5,018 |
| Culvert walls, surface yards | | | 356 | 690 | 1,038 | 2,084 |
| Unit cost | | | | $4.74 | $4.29 | $4.46 |
| Concrete top, cubic yards | | | 52 | 125 | 84 | 261 |
| Unit cost | | | | $12.97 | $11.84 | $12.51 |

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# Port-Terminal Improvements on the Pacific Coast

By PAUL WHITHAM*

## Introduction

The comprehensive development of port-terminal facilities at Pacific Coast cities followed an awakening to the opportunities expected to result from the opening of the Panama canal. Consequently, most of the waterfront facilities of importance from San Diego to Vancouver, British Columbia, are of recent construction and on that account are of particular interest.

A port terminal, to the average mind, means wharves and docks. As a matter of fact, a wharf or pier is a mere detail in the general terminal scheme. The completed port-terminal system is a combination of railway tracks, marginal streets, warehouses, wharves, sheds, mechanical equipment, and all the facilities that have to do with transfer of commodities between land and water carriers. Each one of the facilities mentioned is a detail unit which to be fully efficient must be co-ordinated with the other units in such a manner as to make of the whole a well balanced terminal system.

In view of these facts, the subject of port-terminal improvements naturally resolves itself into two parts, namely:

Part I. General Terminal System.

Part II. Detail Improvements.

In this paper the subject will be discussed under these two heads.

## Part I. General Terminal System.

As a rule, the more important ports are both industrial and commercial in their activities, with the result that the development problems are diversified and complex. Analyzed, to get at the fundamentals, the matter is really not as complex as it would at first appear.

The backbone of the port-terminal system is the marginal street, and belt-line railway. Carrying out the analogy, the deep-sea terminals would be the arms of the port, reaching out for the over-seas traffic, and the local shipping facilities would be the legs carrying the burden of local distribution. Of these three factors, the first is the most important; for upon it as a basis the other two should be built.

**Marginal Streets and Belt-Line Railways.**—As a general rule the various districts of a port should be co-ordinated by a marginal street, paralleling the waterfront as far as the physical conditions will permit. The belt-line railway should, in most cases, be situated on this marginal street and should not only connect the various waterfront improvements, but also with the trackage systems serving the jobbing house and industrial district, making them virtually a part of the port terminal system, the ideal condition being that the railway system be so connected and co-ordinated with the waterfront facilities that every jobbing-house industry and warehouse merchant in the terminal district may conveniently ship over all or any of the transportation agencies doing business in the port. The Pacific Coast cities have a considerable advantage over the older communities, on the Atlantic, in that their development has not progressed so far as to prevent the bringing about of an arrangement approximating the ideal scheme.

The railway companies have hesitated and in some cases have been averse to joining in a general terminal arrangement. The entire blame for this attitude should not be laid against the railways, nor should their officials indiscriminately be accused of shortsightedness. As a matter of fact, the communities themselves are frequently to blame on account of hostile and unfair treatment of the transportation companies having forced the railways to hold aloof as a matter of self-defense.

This should not be, for the reason that, stripped of superficial differences, the interests of the railway companies and the municipality are fundamentally the same. Both are seeking terminal efficiency. If the problems incidental to the obtaining of the desired efficiency are approached in a spirit of friendly co-operation, I believe that in most instances the railway officials will meet the public officials more than half way.

**Deep-Sea Terminals.**—The spectacular features of a port's terminal facilities are the docks and equipment designed to care for the deep-sea shipping. Such docks need not be situated immediately adjacent to the business centre of the city. In fact, the importance of ample railway service and yardage facilities frequently makes it advantageous to locate the deep-sea terminals at some distance from the retail districts.

It has been proved economical in many instances to group several docks together in one working and administrative unit, and in connection therewith to provide warehouses, grain elevators, and cold-storage buildings, so a vessel without changing berth can load or discharge a large variety of commodities.

Where land is available back of the docks and warehouses, it may be successfully utilized for intensified industrial purposes, as it is particularly attractive to enterprises depending largely on extensive transportation conveniences.

**Local Shipping Facilities.**—These may be described as including landings, docks, warehouses, and conveniences for the accommodation of ferries, local and coastwise shipping, harbor boats, lighters, and motorboats. The principal local terminals should be situated

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adjacent to the retail section of the city. If the waterfrontage of the port is extensive, there would naturally develop sub-centres at points convenient for local distribution.

It is not so important that the piers and wharves devoted to passenger, express, and package freight traffic be served with railway tracks, but it is a convenience that should be secured if possible.

The industrial districts should in no wise be overlooked, as the growth of large population centres is dependent even more on industry than commerce. The outlying districts where land values are low are the logical situations for industrial waterfront development. If deep water is available, all the better, but the shallow portions of the harbor may be used advantageously if sufficient depth is obtained to permit the navigation of local steamers, harbor boats, and lighters. The major portion of the industrial waterfront should be given over to development by private industrial concerns, but a sufficient percentage should be reserved for public landings as will insure shipping facilities to those industries not actually on the waterfront.

**Advantage of Comprehensive Plan and Directing Body**

Whether or not a port is developed by private or public enterprise, or in part by both, this much is clear: In order to obtain the maximum of terminal efficiency a comprehensive plan should be prepared and followed. In order to make sure of the carrying out of the plan in its fundamentals, and to insure that the various sections of the waterfront are utilized to the best advantage, for the purposes to which they are best suited, the situation must be under the general control of some governing or directing body.

A transportation company or industrial concern, when making an improvement, very naturally endeavors to meet its peculiar needs as best it can, within the limits of the property at its disposal, without reference to the general requirements of the port as a whole. The inevitable result of such a policy is a hodge-podge development working greatly to the disadvantage of the port as it grows in population and commerce.

The foregoing discussion of the general problems of port-terminal development is for the purpose of establishing a basis upon which to describe the port-terminal improvements on the Pacific coast. It would not be practicable within the limits of this article to describe all the ports along the coast, consequently, the descriptions will be confined mainly to the ports of the three largest cities, that is, Seattle, San Francisco, and Los Angeles.

**Puget Sound Ports**

From a practical standpoint, the above heading is a misnomer; it really should be the Port of Puget Sound.

That portion of Puget Sound including Everett, Seattle, and Tacoma, from a transportation standpoint constitutes one port terminal district, and the policies in regard to its development should be based on that theory, if the best results are to be achieved.

Seattle is the financial and population centre, consequently on Elliott bay will be situated the more intensified activities. At Everett and Tacoma there is ample waterfrontage and extensive tide flat areas suitable for industrial enterprises and the shipping concerns requiring large areas on which to economically transact their business. Neither of the last named places has organized the development of its splendid possibilities. Seattle, on the other hand, some three years ago, organized a port commission, which has undertaken the comprehensive development of the port.

The city is built on a hilly strip of land from two to six miles in width, situated between Puget Sound on the west and Lake Washington on the east. About halfway between Salmon bay, an inlet from Puget Sound, and Lake Washington, is Lake Union, in practically the heart of the city. Nature went a long way toward connecting Salmon bay with the two lakes. What little was left for man to complete is being done by excavating what is known as the Lake Washington canal, and the construction at the narrow entrance to Salmon bay of a lock capable of passing the largest vessels now plying the Pacific. Upon the completion of this lock, within the year, Salmon bay will become a non-tidal basin about the size of the combined Royal Victoria and Edward Dock basins of London. Its level will be that of Lake Union, approximately 8 ft. above high tide.

The level of Lake Washington will be lowered 8 ft. to the level of Lake Union. Thus will be created a non-tidal, practically fresh-water harbor, with approximately 100 miles of shore line.

Extending southward from Elliott bay is the Duwamish valley, from one to several miles in width. This low-level land connects with the southern end of Lake Washington, at Renton, and by the White River valley with Tacoma. The Duwamish river is being straightened and canalized southward from Elliott bay, some five miles, thus creating an industrial harbor, the swampy lands on both sides of which are being reclaimed with the dredged material at the south end of Elliott bay. Over a thousand acres of tide flats have already been reclaimed and to a large degree utilized.

The major portion of the existing shipping facilities are along the easterly shore of Elliott bay.

**Railway Situation**

The principal railway entrances to the city are from the north and south, forming a big 'Y,' the stem of which lies in Duwamish valley, and the respective branches following the shore of Puget Sound and the west side of Lake Washington northward from Union bay. The projected junction is at the northerly end of Lake Union, which will become an actuality when the tracks on the southern tide flats are connected with the Lake Union belt line by means of a tunnel under the city. The real junction at present is in the low-lying draw, situated between Salmon bay and Smith cove, at the northerly end of Elliott bay, known as the Interbay district. Naturally the railway yards and termin-

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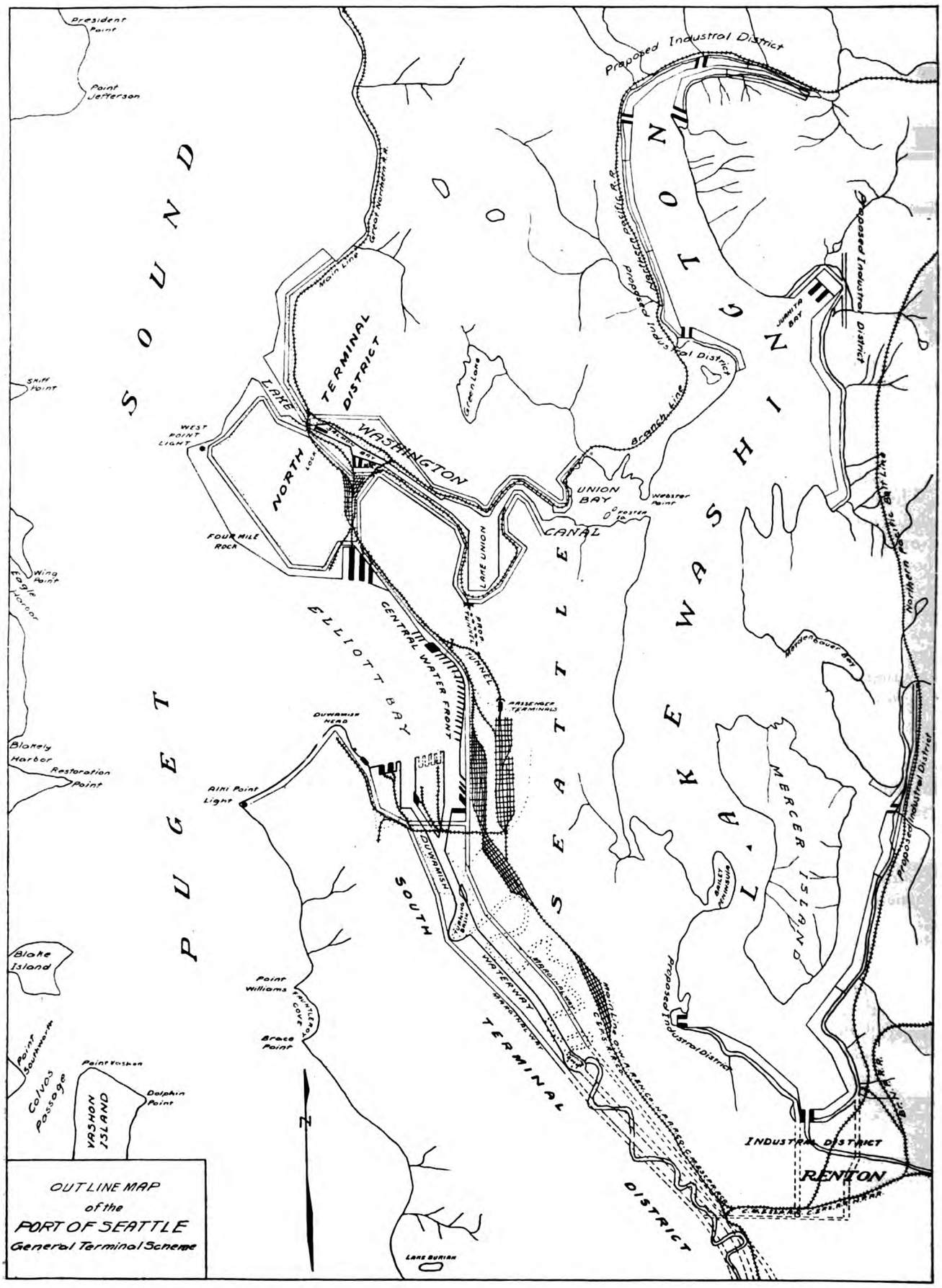


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als have been developed at the Interbay or North Terminal district, and on the reclaimed Duwamish flats or South Terminal district. At some distance from the city the railroads have located their larger general classification yards, designed to serve the entire Puget Sound Terminal district.

Marginal streets have been located about the shores of Elliott bay, with extensions into the North and South Terminal districts. Proceedings are now under way for the condemnation of two marginal streets, one on each side of the Duwamish waterway. These marginal streets will be occupied by extensions of common-use railway tracks. It is proposed that the marginal streets in the Duwamish valley be extended eventually to a connection with the marginal streets recently platted along the waterfront, at the south end of Lake Washington. About the lake are several districts suitable for industrial waterfront purposes, particularly at the north and south ends where marginal streets have been platted in contemplation of belt-line railway service.

Around Lake Union and along both sides of Lake Washington canal marginal streets are in existence or are being acquired. A number of connections and extensions are yet to be made in order to complete the systems, but as the matter stands, the backbone of Seattle's port-terminal system is probably better developed than that of any other city in this country. No little credit for this is due to former city engineer R. H. Thomson, who had the foresight to see and the ability to force the laying out of the foundation of the system before its need was generally recognized. The work of Mr. Thomson was emphasized and enlarged upon by Virgil G. Bogue, of New York, who, in the preparation of the plan of Seattle, devoted particular attention to the railway and waterfront development.

The Bogue plans are being followed in their principal features by the various public and private authorities, and, in particular, the efforts of A. L. Valentine, superintendent of public utilities, are resulting in the development of the railway and industrial terminals in accordance with a comprehensive plan.

### Deep-Sea Terminals

Knowing the railway and topographic situation, it is not difficult to see the logic for choosing the North and South Terminal districts as the sections that may be developed most advantageously by the construction of docks, warehouses, railway yards, etc., designed for the accommodation of the over-seas shipping.

The North Terminal district has frontage on both Elliott and Salmon bays, the two-mile draw between the bays being well adapted to railway trackage, warehouse, and industrial purposes. At the Elliott Bay end the plan provides for a series of great piers varying from 1500 to 2500 ft. in length.

The South Terminal district has a splendid frontage on Elliott bay. The principal features are the east and west waterways, each 1000 ft. wide and approximately a mile in length. Between the two waterways is about 400 acres of reclaimed land, known as Harbor island. At the northerly end of this it is possible to construct five double-width piers, 1500 ft. or more in length.

The present port improvements in this district are on the east side of the waterway adjacent to the built-up section of the tide flats.

### Local Shipping Facilities

Joining these two terminal districts is a three-mile strip of land along the east shore of Elliott bay wide enough to allow for the marginal street and one line of warehouses between it and the low bluff. This is known as the Central Waterfront district, and being in front of the business centre is largely used for and is particularly adapted to the local and coastwise shipping. Here are located a number of privately constructed passenger and package freight piers, that have the finest passenger accommodations of any piers on the coast. The Port Commission has erected its initial unit in this district at the foot of Bell street.

The completion of the Lake Washington canal will make practically all parts of the city available by water transportation. This, coupled, with the fact that Puget Sound itself, with two or more thousand miles of shore line is one huge harbor, indicates that an enormous water carriage business is bound to develop as it has at New York city.

Lake Union, situated in the heart of the city, will become the crowded terminal for a great deal of this business. Public landing sites have already been acquired in anticipation of the development of Lake Union. Those who have had to do with the planning of the Port of Seattle on such broad lines undoubtedly have been inspired by the greatness of the natural harbor.

### San Francisco Bay Ports

Rivaling Puget Sound as a great natural harbor is San Francisco bay. The expression 'San Francisco Bay Ports' is also a misnomer, for the reason that the bay is, and from a practical administration and operating standpoint should be treated as one big port terminal.

San Francisco, like New York, is laboring under the handicap of having its port politically divided into two parts, with a resultant lack of co-ordination and balance in development. Also like New York, the principal railway terminals are on the side of the harbor opposite the central business section of the community. Under the circumstances, it would appear that the trans-shipping docks, where heavy direct ship-rail transfers take place, would naturally be located on the east side of the bay, in close proximity to the railroads and their yard facilities. The principal dock improvements have been made on the west side of the bay, where the waterfront is owned by the state and directed by the State Board of Harbor Commissioners. The next most important improvements have been made on

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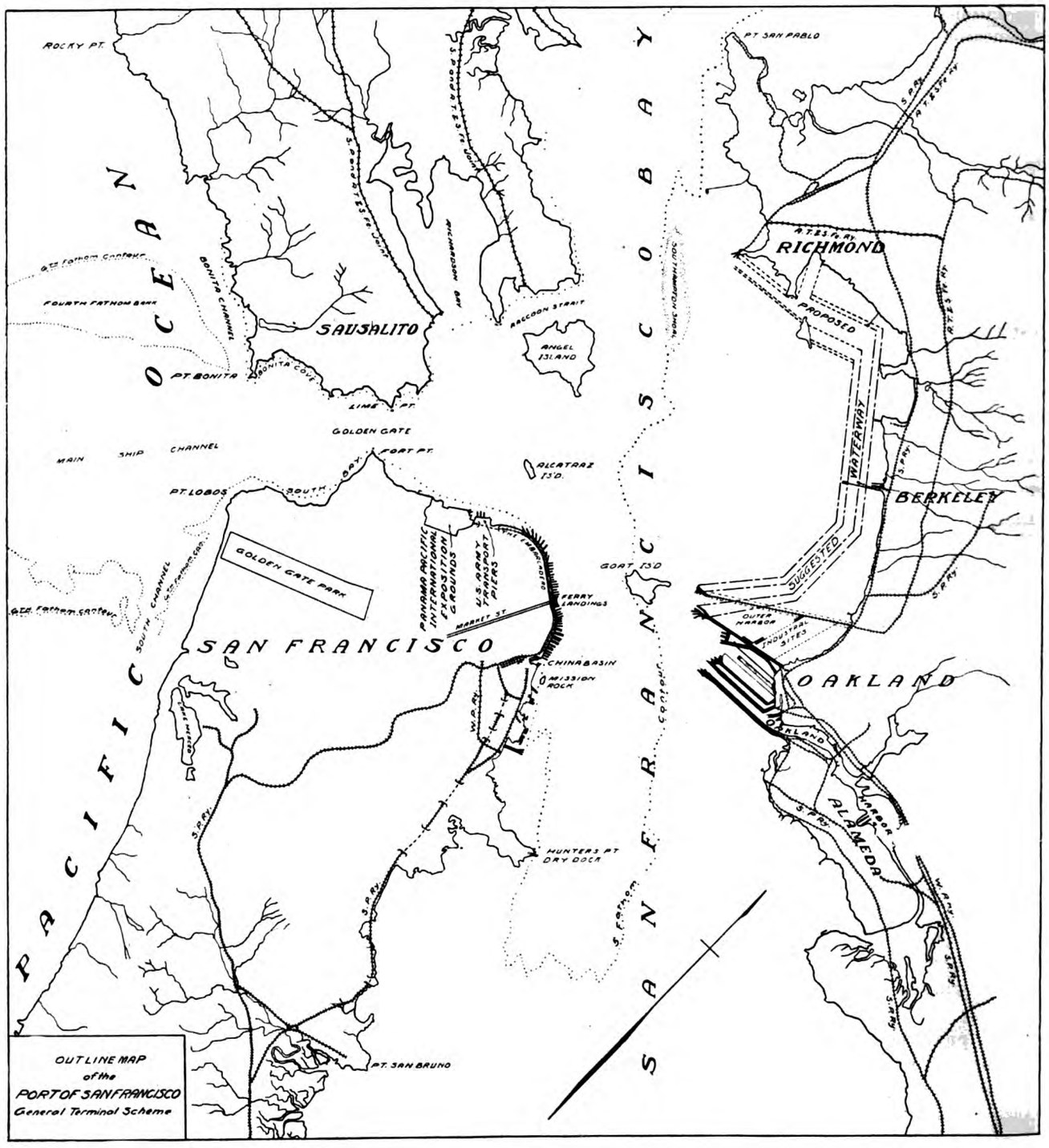
the east side of the bay, and in the vicinity of Oakland estuary. The other improvements are mostly ferry terminals for the various railroads and transportation companies. At Richmond, a little north of Berkeley, some facilities have been provided in accordance with a comprehensive plan of development, prepared for the city of Richmond, by Haviland & Tibbetts, engineers, of San Francisco.

### Railway Situation

As previously stated, the principal railway terminals are on the east side of the bay, the Southern Pacific alone having track access to the San Francisco peninsula. The other trans-continental roads have small terminal facilities on the west side which they reach by car ferry service. The docks on the west side between China basin and the U. S. Transport docks, are served by the belt-line railway constructed and operated by the State Harbor Board. The Embarcadero, a splendid marginal street, covers the same territory.

On the east side of the bay the railway service as related to the waterfront, outside of the matter of ferry terminals, is in the process of being formed and shaped to meet the needs of new conditions.

A marginal street and belt-line system has not yet been established, although various suggestions have

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been put forward with a view to bringing about a coordinated waterfront and industrial development embracing the east side from Richmond to Alameda.

### Deep-Sea Shipping Facilities

These are not clearly separated from local accommodations, most of the docks used by the over-seas trade are on the west side. Unlike similar terminals on the Atlantic, and the new ones recently constructed at Seattle, and contemplated at Portland and Los Angeles, warehouses have not been provided in connection with or supplementing the docks. The new piers are splendid structures with large shed areas. Additional piers are being constructed under the direction of Jerome Newman, chief engineer to the Harbor Board. On the east side, between the San Francisco-Oakland Terminal railways and the Southern Pacific moles, the city of Oakland has planned and done some work on an outer harbor. The dredged material is being utilized to reclaim tide flat properties back of the proposed docks, for warehouses and industrial purposes. The proposed development at Richmond contemplates a similar improvement, combining deep-sea docks, warehouses, and industrials. One suggestion contemplates the connecting of the Richmond and Oakland improvements by an inside waterway, the excavated material from which it is proposed to use in reclaiming the fore shore and the construction of a filled dike on the bay side.

Local shipping facilities are centralized on the west side, at the great ferry terminal at the foot of Market street. This is probably the largest ferry terminal in the world. The bay and river steamer landings are mainly adjoining the ferry slips. The inner harbor on the Oakland side has developed largely as a local distributing and industrial district.

Without being fully informed in regard to the practical difficulties in the way of carrying out the work the suggested scheme embracing the waterfront between Oakland and Richmond appears to offer an opportunity to develop a waterfront industrial district on a magnificent scale. The suggested crescent shaped waterway corresponds in size to half the circular waterway in the Jamaica Bay district, New York, where work is under way on the largest scheme proposed of its kind in this country.

The San Francisco Bay port terminal is not only impressive on account of the splendid facilities already provided, but also in view of the magnificent possibilities if the opportunities are made the most of.

### Southern California Ports

Just this side of the Mexican border, Nature provided a splendid little harbor—little only in comparison with the great harbors of Puget Sound and San Francisco, which are really inland seas.

San Diego is alive to the advantage of its harbor and has supplemented Nature by the erection of a pier and bulkhead wharf, the initial unit in an ambitious comprehensive scheme.

The Port of Los Angeles, as an example of the creative genius of man, should perhaps be given position higher than Seattle or San Francisco. In the last named ports little was left for man but the provision of terminal facilities, while Los Angeles had the task of creating the harbor preliminary to the erection of docks and other facilities.

The Los Angeles situation is unusual in that the city itself is situated some 20 miles inland. In fact, it was not until it had become a large and prosperous inland city that Los Angeles decided to develop a front door facing the sea. To accomplish this, a narrow strip of land 22 miles long was annexed to the city, which then proceeded to annex the waterfront towns of San Pedro and Wilmington. Since then the development of both a harbor and port terminal facilities have been going on simultaneously.

To begin with, there was really nothing that could be termed a harbor, although the open bay of San Pedro was partly protected on the west by the rather high headland and on the south by Santa Catalina island. The outer harbor was formed by the construction of a long breakwater, extending eastward from the San Pedro head.

The inner harbor was formed by the excavation of channels from the shallow tidal areas back of the Terminal Island sand spit. Terminal island is to be made really an island by the excavation of a channel connecting Wilmington and Long Beach basins. As indicated on the map, it is proposed that the outer harbor be enlarged ultimately by the construction of another breakwater, to extend from near the outer end of the existing jetty to a point far enough northeasterly to protect the Long Beach entrance to the inner harbor. Back of this suggested breakwater it is possible to create a huge deep-sea shipping terminal by excavating slips and filling the tide flats westerly of Terminal island.

### Railway Situation

The port is connected with the city proper by both the steam railway and electric lines. Having in mind that the belt line and terminal tracks should be operated in common or made independent to such an extent that shippers in the port and industrial districts might be in a position to ship *via* any or all the carriers, the port authorities have about consummated an arrangement by which the port will be made a common terminal district open to all. This arrangement is to be brought about, it is understood, by an agreement with the railways, whereby they will operate the terminal as a joint proposition. What is known as 'Harbor boulevard,' is being extended to the outer docks, making it feasible to maintain a truck service between the harbor and the city.

Deep-sea shipping facilities are situated in both the inner and outer harbors, but pre-eminently in the outer harbor, where splendid improvements are in service or under way.

Local shipping facilities, designed to take care of

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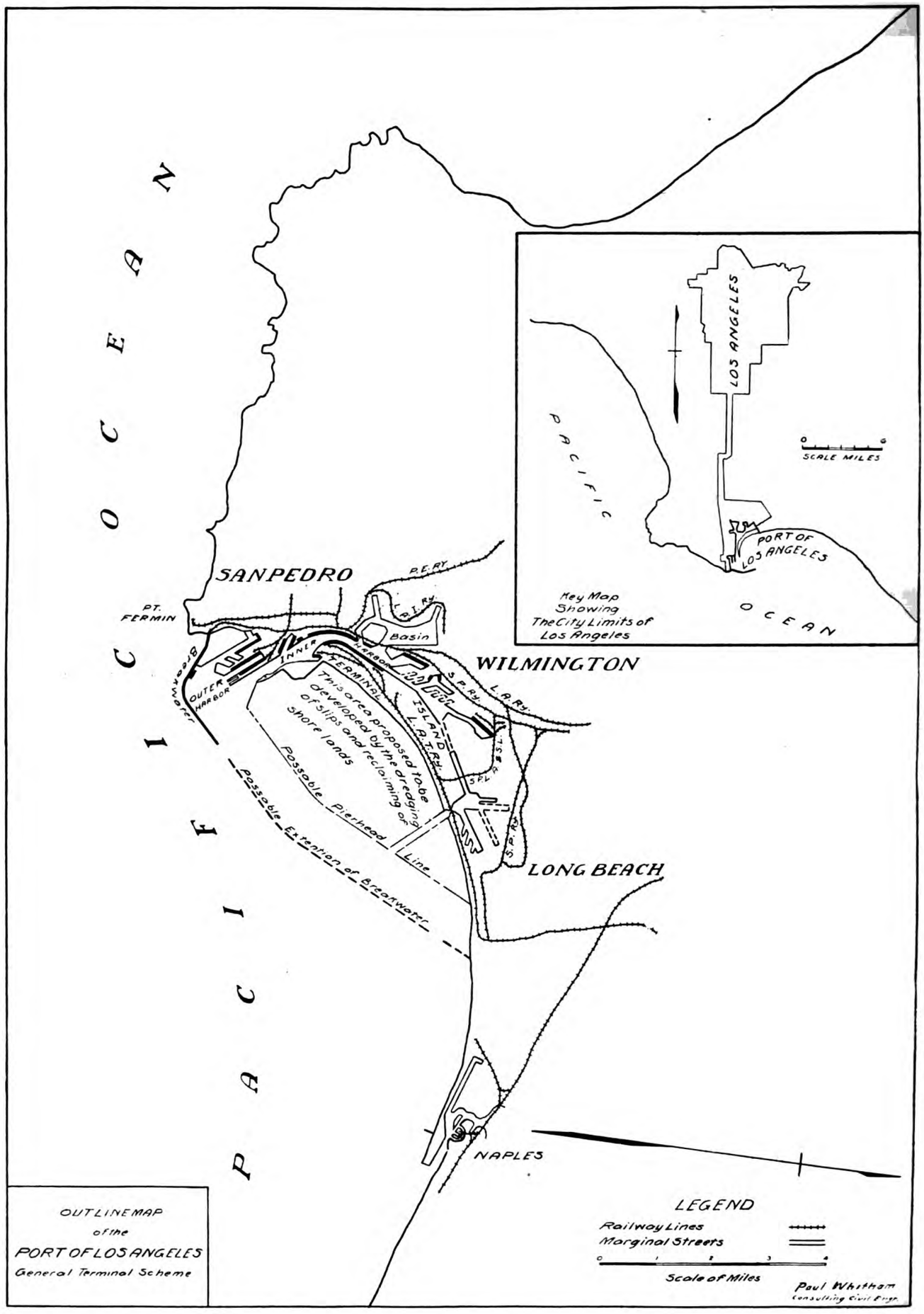


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more purely city business, are not prominent as in the cases where the city itself is situated on the waterfront and where large bodies of inland waters invite the growth of a water cartage traffic.

About the inner harbor and on Terminal island a splendid industrial development is possible, if properties are well laid and shaped for that purpose.

Without the advantage of a natural harbor, Los Angeles is creating a port and installing therein docks and warehouses as good as the best on the coast.

### Conclusion

The cost of living is materially affected by the cost of transportation. In this country the railway companies have broken the world's record in the matter of reducing transportation costs between terminals. The transportation charges across the ocean are frequently little more than the cost of handling and storing at the terminals. In other words, while the transportation costs between terminals have been reduced to remarkably low rates, the handling and trans-shipping costs have remained stationary or increased. There are several reasons for this—among them being the failure to invent and provide mechanical handling equipment adapted to the business of discharging, storing, and loading mixed cargoes. One of the prime reasons is that terminal situations have been allowed to grow without definite forethought and planning, resulting in a hodge-podge inefficient arrangement.

The Pacific Coast cities having started their improvements recently are in a position to profit by the mistakes of older communities, and in a large measure are doing so, although much remains to be done. The port that is most successful in the matter of reducing its terminal costs by the exercise of intelligent forethought will gain an important handicap over its competitors in the race for commercial supremacy.

[EDITOR'S NOTE.—This is the first of a series of articles by Mr. Whitham, dealing with the ports on the Pacific coast. The second will appear in the May number.]

# Some Geometrical Features of the Anticline*

By Sir THOMAS H. HOLLAND

The anticline to the oil prospector is like the quartz reef to the gold miner, and often is as treacherous. Whenever it can get a fair chance, oil chooses for its resting place the higher parts of the anticlinal crest or dome; true, it is sometimes caught in other situations, some of them rather compromising, even to the notoriously vagrant character of oil, and it has even been reported in commercial quantities in synclinal troughs, though these occurrences are occasionally in areas where the tectonic features of the strata are well concealed by a mantle of vegetation and decomposition products.

There are two great classes of anticlines:

(1) Those that are usually figured in the average textbook of geology, and (2) those that occur in nature.

The former have limbs symmetrically disposed with reference to a vertical median plane, and their axes are as near the horizontal as the draughtsman can make them. The anticlines of nature are, however, generally asymmetrical, with a pitching axis, which rises and falls as it rolls across the country in pythonesque undulations; the outward and visible shape is often also but a partial representation of its internal tectonic structure.

The problem of locating favorable well-sites in a series of petroliferous rocks that are folded, Jura fashion, into a series of alternating anticlines and synclines, narrows down mainly to a consideration of the local degree of asymmetry and the way in which the anticlinal axis pitches. Departures from these ideal conditions may force the geologist to take into serious account:

(*a*) Excessive asymmetry resulting in the inversion of one limb,

(*b*) The local passage of folds into faults,

(*c*) The shearing of the limbs of the anticline, and

(*d*) The so-called diapir structures described by Professor Mrazec in Rumania.

The commonest problem before the oil geologist is that of locating a point vertically above some subterranean crest known or suspected to be petroliferous. In this essay I propose to discuss the geometrical features of the anticlinal fold merely with the intention of forming some mental estimate of what the usual pitfalls are and how much they really matter in ordinary practice.

To clear the ground we might just pass in rapid review the leading types of anticlinal folds, namely:

(1) The nearly symmetrical open anticline, which a parsimonious nature rarely provides.

(2) The closed anticline, in which the oil-pool is so narrow that one's neighbor is generally found already to have taken up the only valuable ground.

(3) The anticline which is asymmetrical to varying degrees, and may be broad, narrow, closed, or carinate.

(4) The anticlinorium in which there may be oil abundant enough to provide wells in subsidiary synclines, or only sufficient to provide local pools.

One would have imagined that no one with an elementary idea of geometry would think it unimportant to take the degree of asymmetry into consideration; yet, among young geologists this error is nearly as frequent as their common impression that all coal is of carboniferous age. Every geologist can recall instances of wells being drilled right on the visible crest of an asymmetrical anticline; others which have been drilled on the wrong side of the superficial crest; and still others which, although on the right side, have been located so as to be

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only partly successful. It ought not to be necessary to deal with more than the last group of cases, and my short essay, therefore, will be limited to a consideration of the rules which guide the geologist in choosing the most favorable location.

I will commence with illustrations in which the axis is so nearly level that the degree of pitch may be regarded as negligible; in practice, these cases are common, as only a very high degree of pitch will produce an error that is comparable to the factor of safety that must be provided to meet such sources of interminate error as, for instance, the compression and shearing of the limbs caused by the folding movements. These two disturbing features will be referred to in the sequel.

### Asymmetrical Anticlines with Negligible Pitch

When a bundle of beds are bent, anticline fashion, at a sharp angle, the line joining the successive corners or crests bisects the angle between both wings or limbs of the anticline, as in Fig. 1, which shows an asymmetrical anticline with right and left limbs dipping respectively at right angles of 40° and 10°. To reach the crest of the oil-sand, OS, a well would be located at W, to the left of the visible crest, C, and on the gently-inclined limb.

There are three classes of such ideal cases to deal with:

(*a*) Anticlines with limbs dipping in opposite directions, such as that illustrated in Fig. 1;

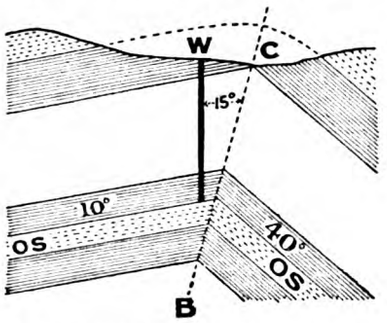


FIG. 1. LOCATION OF WELL FROM AVERAGE DIP.

(*b*) Anticlines with limbs dipping in the same direction, without inversion; and

(*c*) Anticlines with limbs dipping in the same direction in consequence of overthrusting and resulting inversion.

The diagrams next following and forming Fig. 2, 3, and 4, show geometrically how the angle between the vertical line and the crest (or apex) locus is calculated from the inclinations (dips) of the anticlinal wings.

*Case (a).—With limbs dipping in opposite directions, the hade of the apex-locus is half the difference between the dips of the two limbs.*

This case is illustrated by Fig. 2, in which CB represents the apex-locus, while CD and CE represent traces of the limb planes. The limb CD dips at the angle ACD $= \alpha$, while the limb CE dips at the angle FCE $= \beta$. The crest-locus, CB, bisects the angle, DCE, between the limbs, and thus the angles DCB and ECB are equal. CG is a vertical line passing through the apex at the level AF. To make the demonstration more graphic, the angles DCB, BCG, and GCE might be marked respectively $m$, $h$, and $n$. Of these $h$, the angle between the vertical and the bisectrix, is, of course, the *hade of the apex-locus,* which is the angle always required in locating well sites on asymmetrical anticlines.

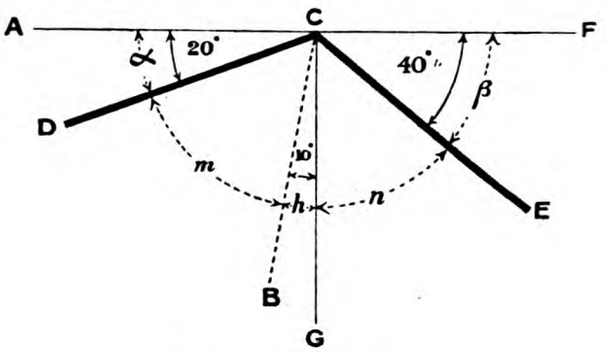


FIG. 2. ANTICLINE, TYPE A.

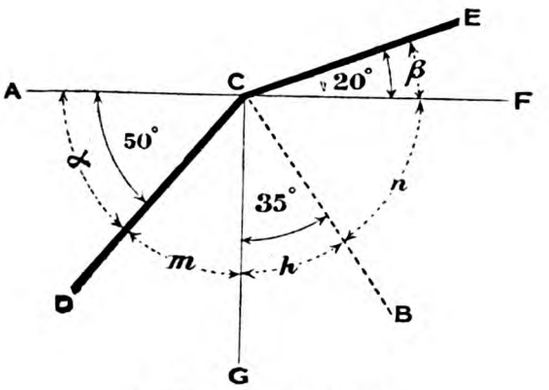


FIG. 3. ANTICLINE, TYPE B.

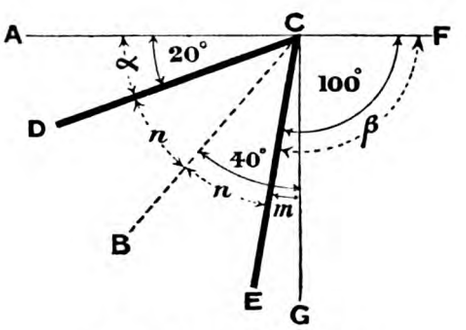


FIG. 4. ANTICLINE, TYPE C.

In this case, because the line CG is vertical while AF is horizontal:

$$\beta + n = \alpha + h + m$$

And as the line CB bisects the angle between the wings—

$$m = n + h$$

Therefore.

$$\beta + n = \alpha + h + (n + h), \text{ and}$$

$$\therefore \beta = \alpha + 2h, \text{ or}$$

$$\beta - \alpha = 2h, \text{ and}$$

$$\frac{\beta - \alpha}{2} = h$$

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In the special case illustrated by Fig. 1, the hade of the apex-locus is obviously $\frac{40° - 10°}{2} = 15°$, while in Fig. 2 the hade is $\frac{40° - 20°}{2} = 10°$.

*Case (b).—With limbs dipping in the same direction, the hade of the apex-locus is half the sum of the two dips.*

This case is illustrated by Fig. 3, in which a similar notation is used for the corresponding angles, namely—

$\alpha$ = the dip of the left wing
$\beta$ = the dip of the right wing
$h$ = the hade of the apex-locus, and
$m$ and $n$ = supplementary angles.

In this case as before—

$$\alpha + m = h + n \quad (1)$$
$$h + m = \beta + n \quad (2)$$

Subtracting (2) from (1) we get—

$$\alpha - h = h - \beta, \text{ or}$$
$$\alpha + \beta = 2h \text{ and } \frac{\alpha + \beta}{2} = h.$$

*Case (c).—With an inverted limb, and consequent dips in the same direction, the hade of the apex-locus is half the difference between the dip of the normal limb and the supplement of the dip of the inverted limb.*

This case is illustrated in Fig. 4, in which $\alpha$ is the dip of the normal wing, while $\beta$ is the supplement of the dip of the inverted wing. Then from the illustration, obviously—

$$m + n = h \quad (1)$$
$$\beta = 90° + m \quad (2)$$
$$\alpha = 90° - (n + h) \quad (3)$$

Subtracting (3) from (2)—

$$\beta - \alpha = m + n + h, \text{ and}$$

inserting the value of $(m + n)$ in this equation—

$$\beta - \alpha = 2h, \text{ and}$$
$$\frac{\beta - \alpha}{2} = h.$$

In locating a well, which is designed to strike some point on the apex-locus, it is obvious that the depth of the point and the hade of the locus are the first data to consider. The distance of the well from the visible crest can then be determined graphically, as in the case illustrated in Fig. 5, in which, with the hade $h$, and the depth DB, the well will be at the distance CD from the visible crest and on the gently dipping wing.

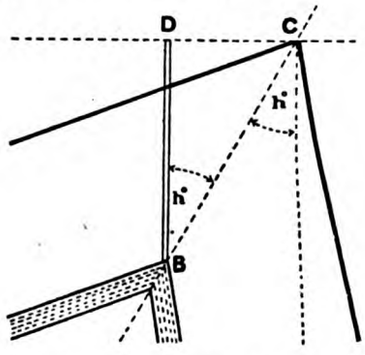


FIG. 5. WELL STRIKING CREST OF ANTICLINE.

This distance can be determined also by simple trigonometrical calculation; for

$$\frac{DC}{DB} = \tan h, \text{ and}$$
$$DC = DB \tan h.$$

**Analysis of Folds**

The very simple cases illustrated by figures 1 to 4 assume the fold in each instance to be referable to two uniformly dipping limbs meeting at the point C. A fold is, however, rarely so simple, and the curves are generally so varied as to require more detailed analysis. In Fig. 6, for instance, the arch indicated by the broken lines can be referred to three plane surfaces, of which two, dipping to the left at 10 and 20° respectively, represent the gently inclined wing, while that dipping 60° to the right represents the steep wing or limb.

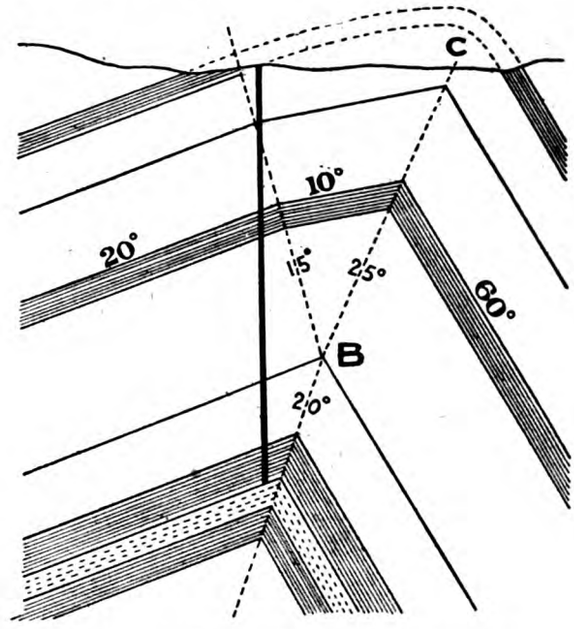


FIG. 6. VARIATION IN HADE OF APEX-LOCUS.

In such a case the crests hade at angles of $\frac{60° - 10°}{2} = 25°$ and $\frac{20 + 10}{2} = 15°$ respectively. These two crests meet below at the point B, where the apex-locus changes direction, and is determined by the outer parts of the limbs that dip at 60 and 20°. The apex-locus below B has then a hade of—

$$\frac{60 - 20}{2} = 20°$$

In Fig. 7 a further refinement is shown by the determination of further dips at the surface on either side of the level part of the arch, namely, 10 and 20° to the left, and 30 and 60° to the right. In this case the crests

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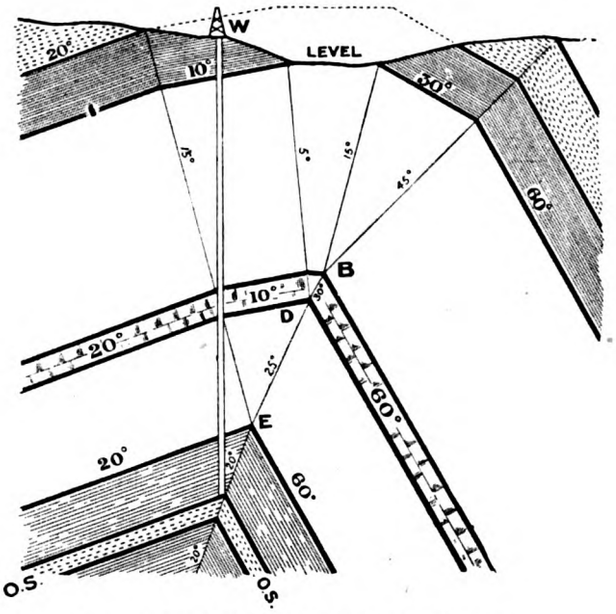


FIG. 7. VARIATION OF HADE OF APEX-LOCUS.

converge with the following hades taken from left to right:

$$(1)\ \frac{20+10}{2}=15^\circ$$

$$(2)\ \frac{10+0}{2}=5^\circ$$

$$(3)\ \frac{0+30}{2}=15^\circ$$

$$(4)\ \frac{30+60}{2}=45^\circ$$

The first two apex-loci to meet are those on the right, which coalesce at B, and then change direction with a hade of $\frac{0+60}{2}=30^\circ$ to D, where the next apex-locus is eliminated; the next series of crests below hade at an angle of $\frac{60-10}{2}=25^\circ$, meeting the next apex-locus at E, and continuing down with a hade of $\frac{60-20}{2}=20^\circ$ to the oil-sand OS, which can be tapped by a well at W.

Frequently the opposite wings are so constant in dip and the arch so narrow that a subterranean crest can be defined by consideration only of the two prevailing dips, as in the case illustrated in Fig. 8, which shows both the map and the section of an anticline with limbs dipping at angles of 10 and 80°. The section shows how the well No. 1 passes through the productive part of an upper oil-sand and just misses the crest of one below, striking into the underlying water, and entering the steeply dipping beds so obliquely that the well is liable to be deflected from the vertical line. Well No. 2 would verify the existence of the upper oil-sand, and, at the same time, is situated conveniently to develop the lower productive sand.

The next feature to consider is the kind of error likely to arise from such an estimate of the apex-locus which is

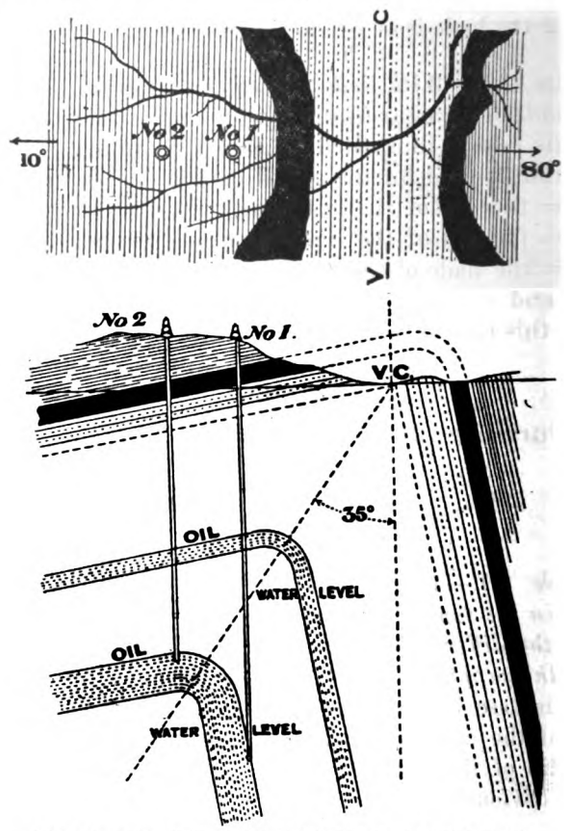


FIG. 8. TWO WELLS ON ASYMMETRICAL ANTICLINE.

based only on a consideration of the prevailing dips in the outer part of the limbs, that is, well away from the visible crest of the anticline. Two cases of the kind are illustrated in Fig. 9 and 10.

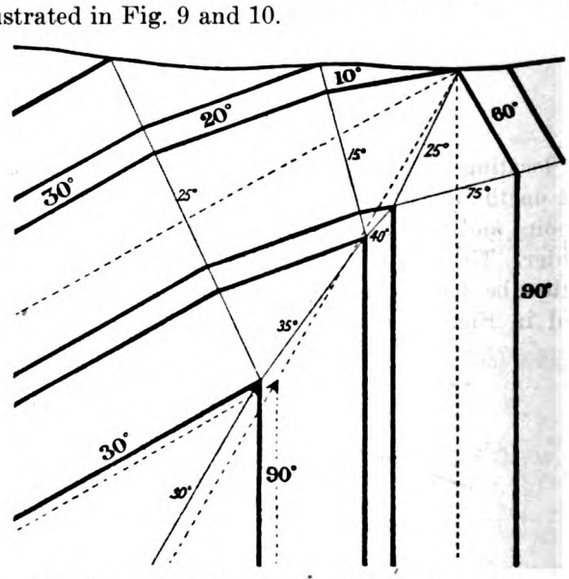


FIG. 9. ERROR IN LOCATION OF CREST OF ANTICLINE.

Fig. 9 illustrates an instance in which estimates based on the outer parts of the limbs only would result in the location of an underground crest on the steep, that is,

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the dangerous side of its actual position as determined by a more complete analysis of the curve. The heavy lines show the results of the detailed analysis, while the broken lines show the results of relying only on the prevailing outer dips.

In Fig. 10, representing an arch of different shape, a

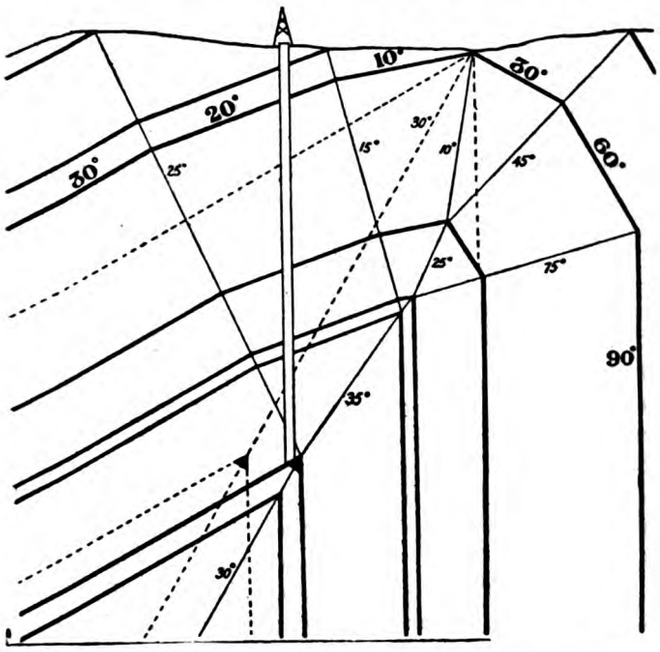


FIG. 10. FURTHER EXAMPLE OF INACCURATE LOCATION.

converse case is shown, in which, by relying on the prevailing outer dips, the subterranean crest is located on the safe side of its actual position as determined by closer analysis of the fold. It is thus important to consider the nature of the curve before deciding on the 'factor of safety' required to be sure that a well will not just miss an underground crest of known depth. Obviously, it is desirable to avoid too much 'safety,' as the well would then be so far back from the crest as to lose some of the advantages of gas-pressure. At the same time, it is important to remember that a well which exactly strikes the crest may be embarrassed by the local accumulation of gas.

### Corrections for the Pitch of the Anticlinal Axis

An ordinary oil-well is drilled with the intention of the boring going down vertically, and, although it does not always fulfil the expectation of the driller, one has to calculate for the ideal, and, what is in practice an approximately true, condition. According to the pitch of the anticlinal axis a transverse vertical plane at right angles to the direction of the anticlinal axis will intersect the planes of true dip at some angle which can be determined from the map.

Thus, in drawing a vertical section across an anticline with a view to calculating the position of some underground crest, it is necessary to determine the apparent dips in the direction of the section, as these will be less than the true dips on either limb of the anticline.

The apparent dip can be calculated from the true dip by a well known geometrical process illustrated by Fig. 11. In this case AB is the direction of true dip, while AC is the direction of the apparent dip to be determined. The difference in the bearing of these two directions is $b$. The line drawn at right angles to the direction of true dip, AB, is the line of strike. Draw BD so as to meet AB at an angle equal to the true dip, $d$. Draw AD at right angles to AB and draw the perpendicular AE equal to AD and at right angles to AC. Join E with the point C, which is on the strike line. The angle ECA ($a$) is thus the apparent dip in the direction of AC. It is

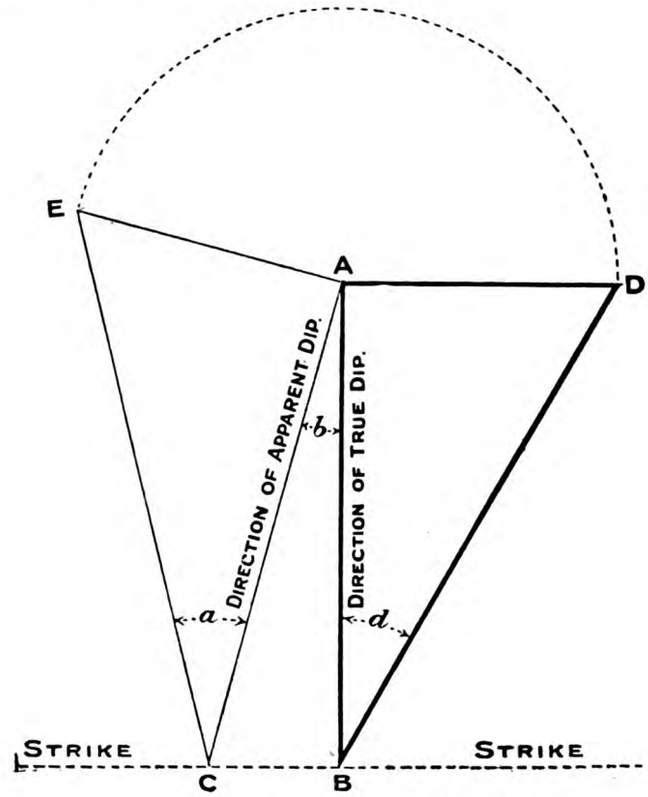


FIG. 11. RELATION BETWEEN TRUE AND APPARENT DIP.

obvious that the apparent dip will be less with the increase of the difference of bearing between the direction of true dip and the direction of apparent dip.

The reason for this construction will become obvious if we cut the diagram along the lines AD, DB, AE, and EC. We can then rotate both triangles on their bases so that E and D will be brought up to coincide vertically above the point A. The triangle ADB will then be a vertical section along the direction of true dip and the triangle ACE will be a vertical section along the direction of apparent dip. The triangle formed by bringing up the points E and D vertically above A will coincide with the plane of bedding, and this plane will include the strike line running through B and C.

Instead of making a geometrical construction it is possible to employ a trigonometrical equation which lends itself suitably to logarithmic calculation. Thus, in Fig. 11, $\frac{AB}{AD} = \cot d$; therefore $AB = AD \cot d$, and

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similarly, $AC = AE \cot a = AD \cot a$. Also, $\frac{AB}{AC} = \cos b = \frac{AD \cot d}{AD \cot a} = \frac{\cot d}{\cot a}$. From this formula, $\cos b = \frac{\cot d}{\cot a}$, either angle can be calculated when the other two are known. In practice the angles $b$ and $d$ will be generally known, while $a$ has to be calculated. The formula can thus be conveniently stated in the form—

$$\cot a = \frac{\cot d}{\cos b},$$

and this can be reduced to the logarithmic form—

$$L \cot a = L \cot d - L \cos b.$$

Now, it is obvious that if there is any appreciable pitch in the anticlinal axis, the dips recorded on the opposite limbs will not be in line, but will meet at an angle on the crest. Judging by experience, it is not unwise to remind the young geologist that an anticlinal axis is not an article that he picks up in the field; its direction and the degree of its pitch are merely calculated from the dip values obtained on the two limbs.

The relationships are shown graphically in Fig. 12,

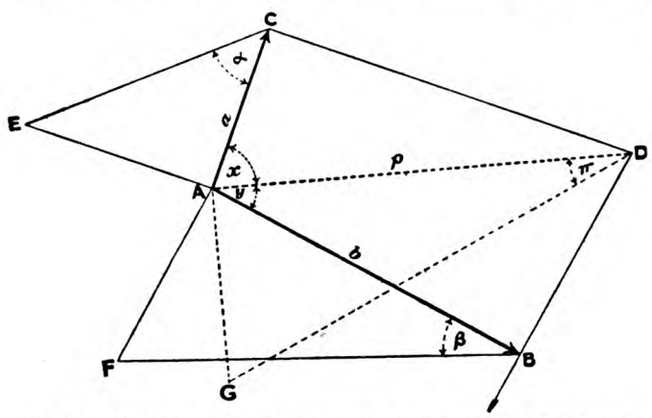


FIG. 12. CONSTRUCTION TO DETERMINE DIRECTION OF ANTICLINAL AXIS.

where AB is the direction of true dip on one limb, and AC is the direction of true dip on the other limb. Now, if AB and AC are in length drawn to be proportional to the cotangents of their respective dips, the strike-lines BD and CD, which are at right angles to the directions of true dip, must be on the same horizontal plane and must meet at the point D. The line joining A and D will then be the plan of the anticlinal axis, which pitches from A and disappears below the horizontal plane CDB at D.

By adopting a similar construction to that used for showing the relation between the true and apparent dip, the three triangles ABF, ACE, and ADG are constructed with vertical sides of the same length; so that, if they be rotated upon their bases, the points E, F, and G can be made to coincide when all three triangles are vertical.

It is obvious from this construction that the amount and direction of the two limb-dips determine both the direction of the anticlinal axis and the degree of its pitch, and the relationship can be expressed trigonometrically. To simplify the formulæ $a$, $b$, and $p$ may be used for the base lines AC, AB, and AG. Then, as the vertical sides of the triangles are all equal—

$$a \tan \alpha = b. \tan \beta = p. \tan \pi.$$

But as ACD is a right angle, $\frac{a}{p} = \cos x$ and, similarly $\frac{b}{p} = \cos y$. We thus obtain the data for dividing the angle BAC (which is the difference in bearing of the two dips), into two parts in the ratio of their cosines.

### Corrections for Shearing, Change of Curvature and Lateral Variation in Thickness

In this sketch of the geometrical features of the anticline I have assumed the existence of folds of incompressible material; such materials of course never occur in rock folds. The process of folding results in extension of some parts of the anticline, compression of other parts, and in shearing of the limbs, which may locally pass into faults. The anticlinal folds, moreover, are never quite concentric curves; the curvature of a folded bed at the surface may decrease or increase in certain circumstances at lower depths. All these features affect calculations based on purely geometrical considerations, and the calculations, therefore, have to be corrected accordingly; thus, frequently the total amount of allowance cannot be determined with precision.

Another disturbing consideration, often greater than any source of error due to secondary changes brought about by the folding movements themselves, is the original lateral variation in the thickness of the beds concerned. Depths calculated from the thicknesses of measured outcrops may be found to be falsified, especially if the outcrops measured are at a considerable distance from the anticline which is to be tested. The kind and amount of lateral variation in the thicknesses of the different beds must be determined and applied as a correction to the estimates made from the purely geometrical proposition. It would make this address unduly long to attempt a discussion of these sources of error, but it is necessary to call attention to them to prevent the possibility of anyone relying on the purely geometrical considerations alone; they represent the ideal conditions which never actually exist in nature.

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**Figures** compiled by the American Iron and Steel Institute show that in 1913 about seven times as much steel pipe as iron pipe was made. In 1905 the amount of steel pipe was only a little more than double the amount of iron pipe. The amount of iron pipe produced year by year, however, remains about stationary or slowly declines, while steel pipe production has rapidly increased. The use of steel in making welded pipe was not successful commercially until about the close of the eighties, but has had a rapid growth in the quarter century since it began, the output last year having been 2,189,000 tons.—*The Mechanical Engineer.*

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# California Agreement on Water-Power Development in National Forests

The secretary of agriculture and the state water commission of California have entered into co-operative agreement for the use of water-powers within the national forests of the state. It is announced that questions which have been pending for some time are effectually settled by this agreement.

The District Forester at San Francisco, mentioned in the paper, is the field officer of the forest service who has charge of the administration of the federal forests in California.

The agreement follows in full:

For the purpose of facilitating the approval of applications for water rights and for the occupancy and use of National Forest land within the state of California for the development of water-power, and in order that uniform action may be taken with respect to such applications, the Secretary of the United States Department of Agriculture and the Water Commission of the state of California, subscribe to the following co-operative agreement:

1. Whenever an application for either a preliminary or a final permit for a water-power site is filed with the District Forester at San Francisco, California, and the evidence of the appropriation of water consists of a notice posted in conformity with the provisions of Section 1415 of the Civil Code of California, immediate notice of such application for a permit, consisting of the name of the applicant, the name of the stream from which the water is to be diverted, the point of the proposed diversion, the date of the notice, and the name of the locator, shall be sent to the State Water Commission.

2. Whenever an application for a preliminary or a final permit is filed with the District Forester, and the evidence of the appropriation of water consists of a copy of an application made to the State Water Commission, or a permit from said Commission under the existing Water Power Act, it will be sufficient to inform the Commission that such application for permit has been filed with the District Forester.

3. Whenever an application is made to the State Water Commission for a permit to appropriate water, and the use of such water will in any manner necessitate the occupancy and use of any National Forest land, immediate notice of the filing of such application shall be given to the District Forester at San Francisco. Such notice shall give the name of the applicant, the stream from which the diversion is to be made, the point of the proposed diversion, the date of the notice, the name of the locator, and a description of the lands that may be within such National Forest.

4. No application for a water right involving the use of National Forest lands will be approved by the State Water Commission prior to notification by the District Forester that a complete application (with the exception of evidence of water appropriation) for the use of the National Forest lands has been filed in conformity with the regulations of the Secretary of Agriculture.

5. If the application filed with the District Forester, as provided in paragraph 4 hereof, is for a preliminary permit, the State Water Commission will defer final approval of any application for water right until notified by the District Forester that a complete final application (with the exception of evidence of water appropriation) has been filed in accordance with the regulations of the Secretary of Agriculture, or that a preliminary permit containing permission to do construction work has been issued. The District Forester will confer with the State Water Commission before arranging the terms of any preliminary permit and will furnish the Commission with copies of such permits immediately upon their issuance.

6. If the evidence of the appropriation of water filed with an application for a final permit for a water-power site consists of a notice posted in conformity with the provisions of Section 1415 of the Civil Code of California, such permit will not be issued until the State Water Commission either approves such appropriation or disclaims jurisdiction. If the applicant relies upon an appropriation under existing law, no final permit will be issued until notice of the approval of the Commission has been filed with the District Forester.

7. No preliminary permit will allow construction upon National Forest land except in an emergency or to comply with the state law, and then only upon approval of the State Water Commission.

8. If the time for beginning and completing construction under any final permit issued by the Secretary of Agriculture is different from that granted by the State Water Commission such difference shall not be deemed to affect in any way the permittee's liability under the state law or the approval of the Commission, or to free him from the cancellation of his permit if he loses his water right under the state law.

9. If any permittee shall lose his water right because of failure to begin construction in accordance with the requirements of the state law and of the approval of the State Water Commission, such loss of right when certified to by the said Commission shall be deemed sufficient cause for revocation of the permit.

10. If either the District Forester or the State Water Commission shall fail to give notification of any action as contemplated herein, within sixty (60) days of the receipt of written report of applications pending, the officer or office so reporting may take action without waiting further for such notification.

In witness whereof, this co-operative agreement has been executed at San Francisco, California, by the State Water Commission of California, on the 27th day of August 1914, and at Washington, D. C., by the Secretary of the United States Department of Agriculture, on the 14th day of November 1914.

(Signed) CHAS. D. MARX,
HAROLD S. POWER,
S. C. GRAHAM,
D. F. HOUSTON,
Secretary of Agriculture.

---

**A method** of utilizing some of the waste heat of the jacket-water of a gas engine is described by J. B. Meriam. A small centrifugal pump is used to circulate at high velocity through the jacket and into an adjoining closed tank, which is kept about half full of water, and back to the jacket. Steam escapes at the water-level and a pressure of about 25 lb. gage is maintained. All the heat that the engine gives to the jacket water, estimated at 38% of the heat units in the fuel, is found in the steam. With a well designed exhaust gas boiler, half of the 38% of the heat of the fuel which is lost in the exhaust gas could be recovered and added to that recovered from the water jacket. The high speed of the water through the jacket sweeps away any steam bubbles that may form on its surface.—*Practical Engineer.*

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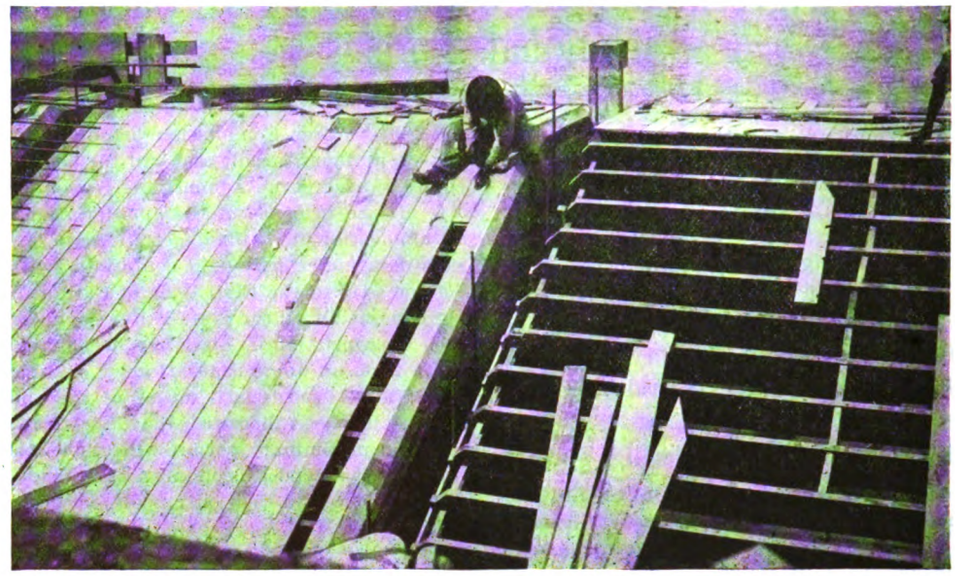

FIG. 1. PLACING FORMS FOR BULKHEADS.

# The Torrance Bulkhead-Wharf at Savannah, Georgia

By M. L. KAUFMAN*

The growing use of reinforced concrete in the construction of wharves and bulkheads has brought out a new type, known as the Torrance bulkhead-wharf, which has been used successfully at Savannah, Georgia. A similar construction has been used at several United States naval stations in connection with docking space for torpedo boats. The general characteristics of the type are, however, better illustrated by the structure at Savannah, a description and discussion of which follows.

The Savannah harbor is inland on the Savannah river and 17 miles from the Atlantic Ocean, and although subject to tides, the waters are fresh and free from teredo and limnoria. The use of timber below mean low water is therefore permissible in permanent construction. Timber piling and sheet piling were used throughout.

The bulkhead wall consists first of all of a rein-

*Pacific Coast representative Torrance interests, 1007 Washington Bdg., Los Angeles.

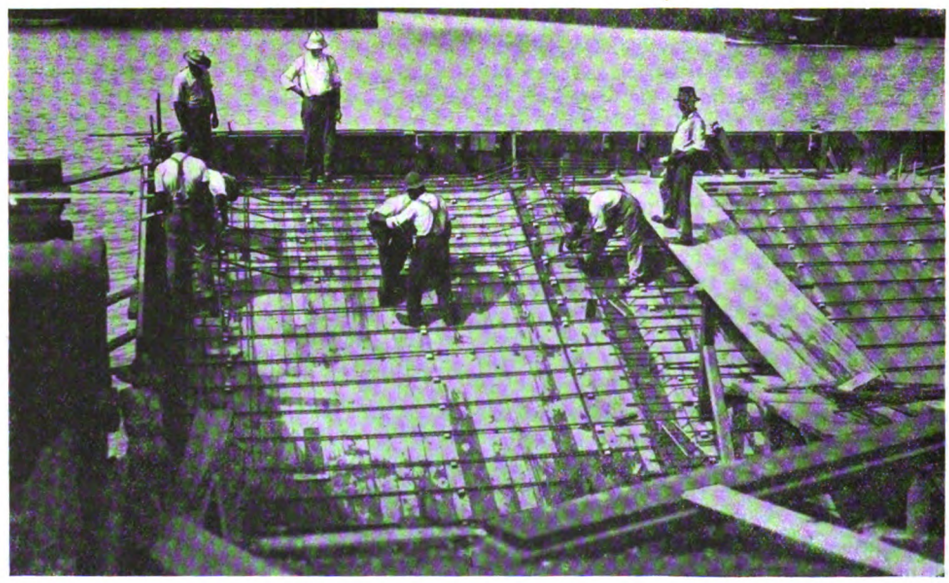

FIG. 2. METHOD OF PLACING REINFORCEMENT.

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forced concrete deck, sloping back from a point four feet from the face of the wharf to a concrete chock-beam at the rear of the wharf, the slope being about

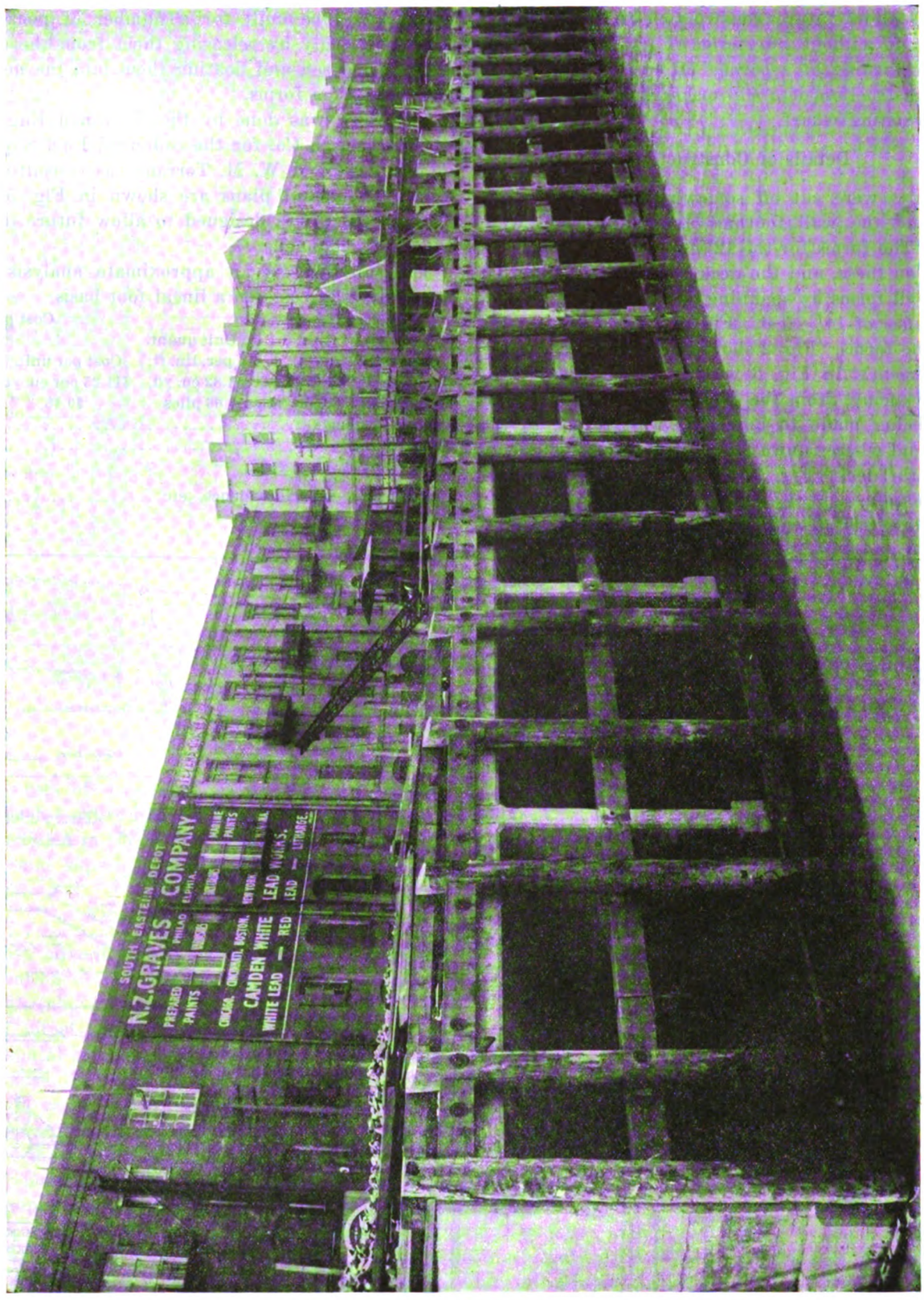


FIG. 4. COMPLETED WHARF.

1¾ : 1, or less than the angle of repose of the fill material, consisting of oyster shells, which are plentiful in the locality. This deck is supported on 12-in. concrete walls, 15½ ft. centre to centre, which rest on rows of piles. At each wall, two batter piles were driven at the heel of the bulkhead, at an angle of 30° with the vertical. Under the chock beams the piles are spaced 3 ft. centre to centre. To retain the material back of the wall, below mean low water, sheet piling was driven down from this level. The mooring posts are of reinforced concrete and built in with the

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deck. The fender system consists of timber piles driven down, and bolted to the concrete, and to horizontal timbers. At the ends of the structure are reinforced supporting walls carried up to the wharf level. This will allow future construction to be built adjacent to it without interference, and it makes possible 'the turning of a corner' in either direction, as in the construction of a slip or pier, without disturbing the existing wharf.

### Details of Construction

The piles were cut off somewhat above mean low water, and the wall footings and chock-beam were poured. The forms for the 12-in. walls were then constructed on these, and the deck forms were supported on the wall forms by spanning with the joists, the entire distance of 14½ feet. Fig. 1 shows the construction of the forms. Fig. 2 shows the method of placing reinforcement. In Fig. 3 we see the work progressively advancing, from the foreground where preparation is being made to build the wall forms, to the background where runways are ready for pouring concrete in the deck. Fig. 4 shows the completed wharf in commission.

The work was all carried on 'in the dry,' and once started there was each day less and less dependence on the stage of the tide as the different parts of the job advanced above low water. In a similar structure, if the extent of the work would justify it, collapsible forms could be built for a number of pockets and used repeatedly by releasing them from the concrete after it had set, and floating them into the next position ready for forms.

The work was done by the Savannah Engineering & Construction Co. for the Standard Fuel Supply Co. on the design of W. M. Torrance as consulting engineer. The detail plans are shown in Fig. 5 and 6. The structure was designed to allow future dredging to a 26-ft. channel.

The following is an approximate analysis of the quantities and costs on a lineal foot basis.

| Items. | Unit quant. per. lin. ft. | Cost per unit. | Cost per lin. ft. of bulkhead. |
|---|---|---|---|
| Concrete in place | 1.82 cu. yd. | $11.25 per cu. yd. | $20.47 |
| Bearing and batter piles | 1.06 piles | $9.45 | 10.02 |
| Tender system | | | 4.75 |
| Sheet piling | | | 3.60 |
| | | | $38.84 |
| Engineering, superintendence, etc. | | | 7.00 |
| | | | $45.84 |

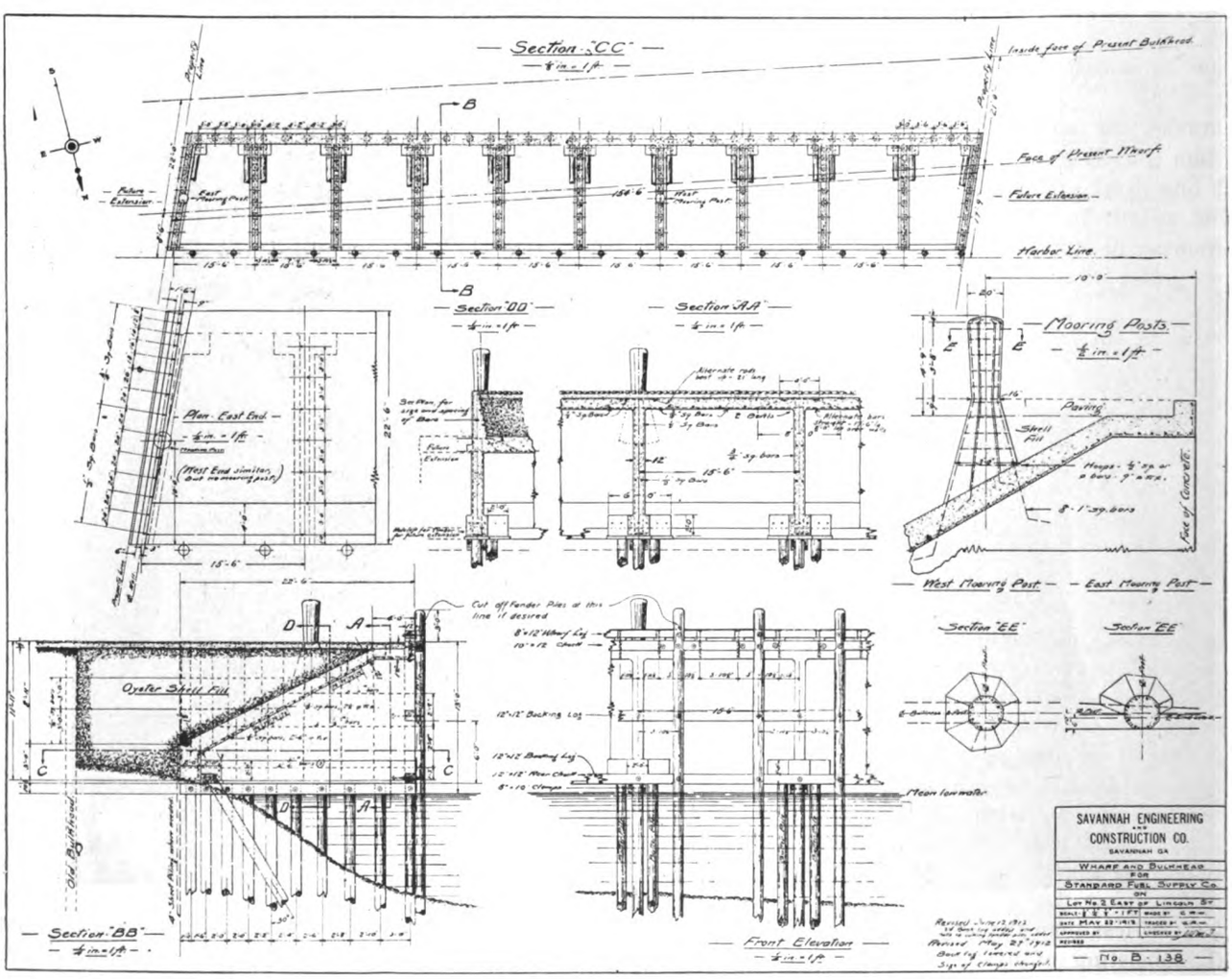


FIG. 5. DETAILS OF WHARF.

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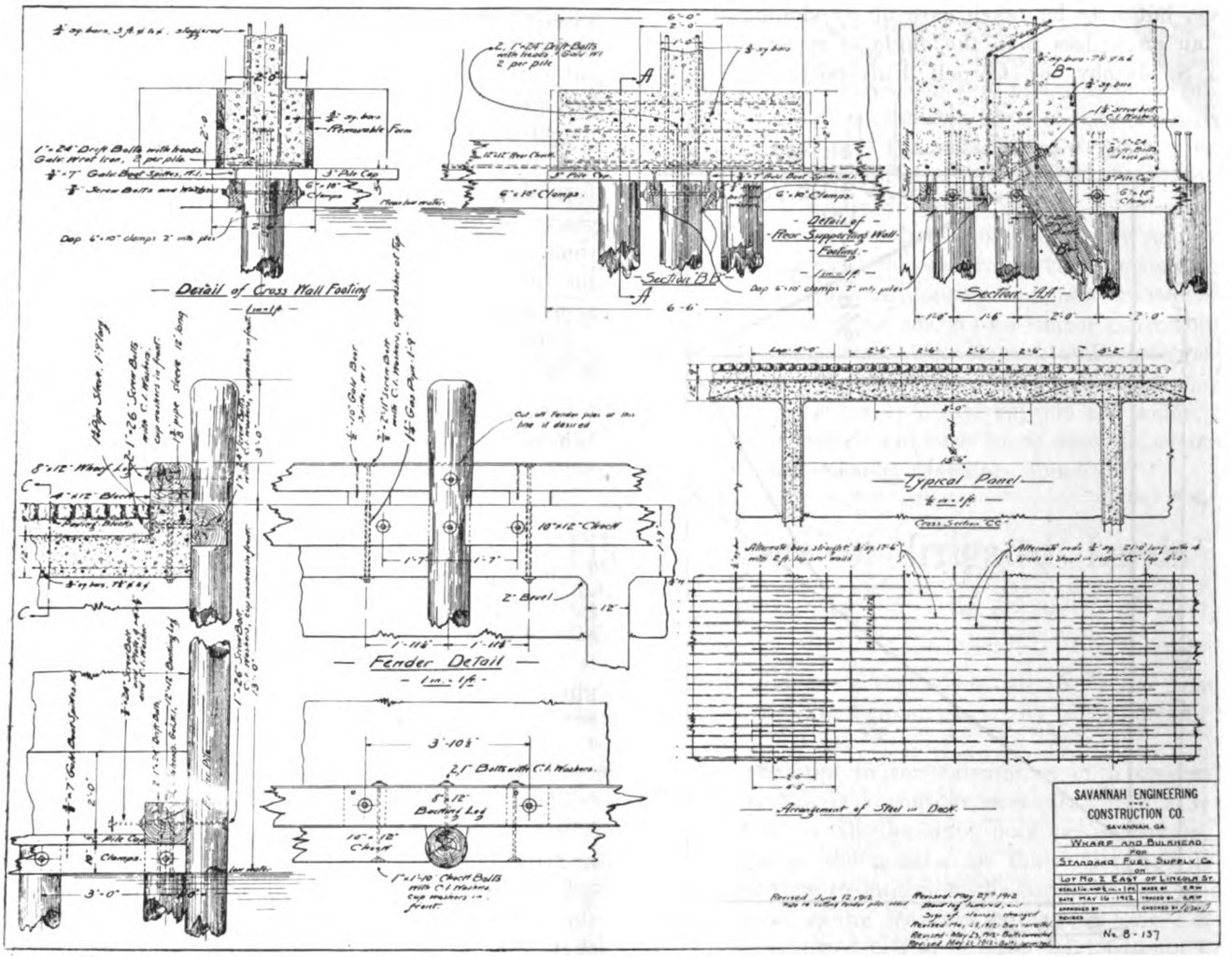


FIG. 6. DETAILS OF WHARF.

As the costs of dredging, rip-rap, fill, and paving vary for each locality and are easily ascertained, they are not included in the above items. The item for engineering and superintendence might be reduced on other work.

### Features of Design

The most advantageous feature of this design is the elimination of reduction of the horizontal thrust of the earth (above mean low water) against the bulkhead wall. Just as in the typical fluid, water, there is no horizontal component of pressure on a horizontal plane because the angle of repose of water is zero, just so with earth (according to our present theories of earth pressures, which are based on those of fluid pressures), there is some plane at which there is no horizontal component of pressure, and the weight of the superimposed mass acts downward, and this plane will make an angle with the horizontal equal to the angle of repose of the material.

Taking up the theory on the same basis as it is treated by Crandall in Church's 'Mechanics of Engineering,' pp. 572 and 573, we have the two wedges of maximum thrust ABC′ and ABC″ balancing each other at the line AB and act only downward. This amounts to making the section ABD′ of the earth act with the bulkhead to help retain the material. As may be inferred, until there is movement of the wedges ABC′ or ABC″, the wedges AC′D′ and AC″D″ are inert, and having no tendency to move or exert pressure except by virtue of their weight, as in the case of ABC′ and ABC″. It is obvious, too, by our conception of the angle of repose, that there will be no tend-

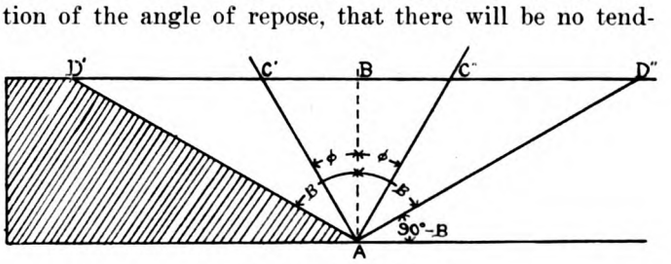


FIG. 7. PRESSURE DIAGRAM.

ency to move along AD″ or AD′, which means, of course, that all horizontal components balance, and that only gravity is active. The same would be true in the application of the superimposed wharf load. This argument has assumed so far that the coefficient of friction of filling on the concrete deck is the same as that of the filling on itself. This is not strictly

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true, but may be taken care of by sloping the deck at an angle less than the angle of repose of the fill. H. S. Jacoby, of Cornell University, in commenting on this feature of the Torrance bulkhead, said that there will be no horizontal thrust provided there is no settlement. Settlement might disturb the plane of contact along AD′, and by destroying the frictional equilibrium, produce a horizontal thrust. Since being put into commission, the wharf has repeatedly been subjected to loads greater than the 600 lb. per sq. ft. for which it was designed, but no settlement has been detected, nor any change of alignment.

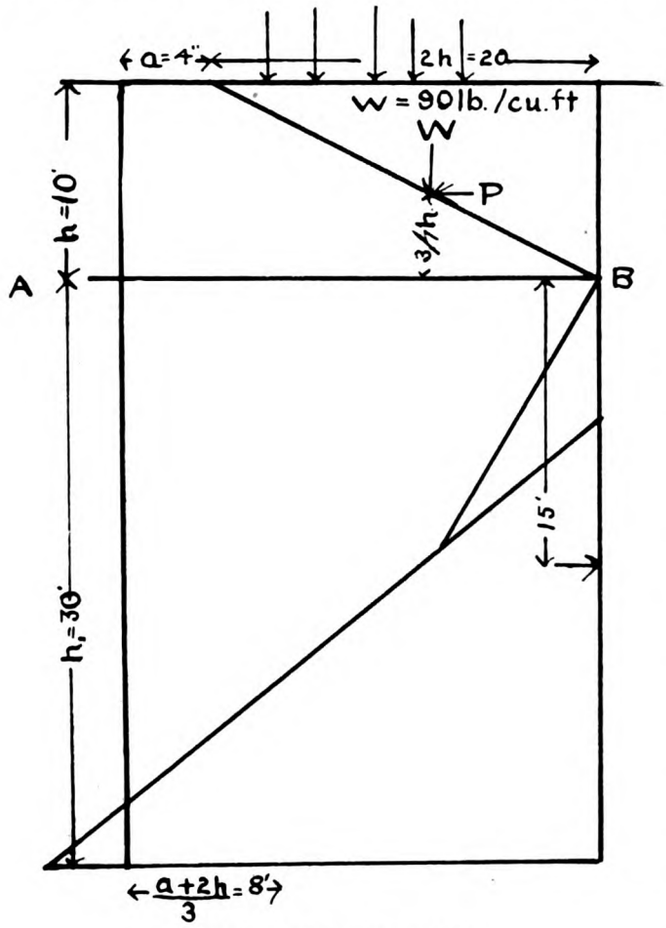


FIG. 8. ANALYTICAL DIAGRAM.

A numerical analysis, using the most conservative formulas, will serve to show further that it is unnecessary to put entire reliance in the theoretical deductions on earth pressures. Take the angle of repose of the fill as 30°, which is a good average. The dimensions shown (Fig. 8) are typical.

From pp. 582 and 583 of the 'Amer. C. E. Handbook' we have the formula:

$$P = \tfrac{1}{2}\,(wh^2 + vh)\,\tan^2\,(45^\circ - \tfrac{1}{2}\,\phi)$$

Where $P$ = Pressure (horizontal)
$w$ = weight of material per cu. ft., say 90 lb.
$h$ = height of wall, say 10 ft.
$v$ = weight of surcharge, 600 lb. per sq. ft.
$\phi$ = angle of repose, say 30°

The expression, $\tan^2\,(45^\circ - \tfrac{1}{2}\phi)$, is a coefficient modifying the pressure which would result from a liquid of the same weight per cubic foot, and in this case is ⅓. The horizontal pressure will be:

| | | |
|---|---|---|
| Fill | $\tfrac{1}{6}\,wh^2$ | = 1500 |
| Surcharge | $\tfrac{1}{6}\,vh$ | = 1000 |
| Total | | 2500 lb. |

The point of application of pressure from fill alone will be at a point one-third the height from the base, and the application of the two combined, will be at 3/7 the height. Moments taken at the outer edge of the middle third at a level of 30 ft. below A-B show that there is an unbalanced, stabilizing moment (in a clockwise direction) of about 86,000 ft-lb., considering the weight of the structure itself, and taking it as fully loaded. The reaction from the sheet piling at A-B will never exceed 4000 lb. per lin. ft. A batter pile with a bearing value of 20 tons driven at an angle of 30° every 5 ft., is capable of taking care of a hori-

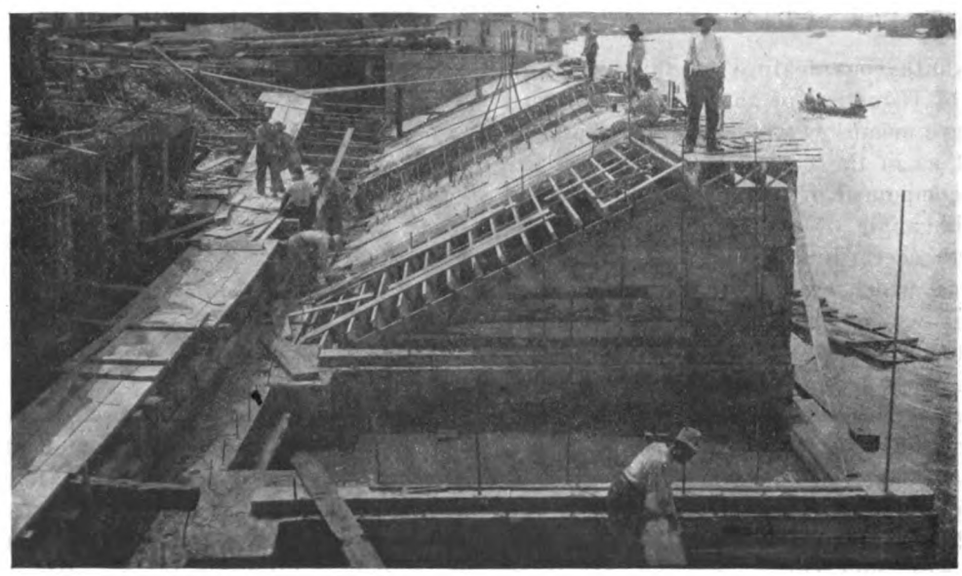

FIG. 3. WHARF DURING CONSTRUCTION.

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zontal reaction of 4000 lb. at the point of its action. Besides this, our unbalanced moment of 86,000 ft-lb. will take care of almost 3000 lb. with a lever arm of 30 ft. The possible action of the vertical bearing piles has been neglected, and may be really considered as another element of safety.

The point of this discussion is to illustrate the stability of such a structure. It is self-sustaining within a very narrow width, the batter piles being driven so as to be contained within the area of the wharf. This does away at once with the old-fashioned 'anchor-back' which at best is uncertain, expensive, and generally unsatisfactory.

The adaptability of this design is also very apparent. Where riprap is available, a riprap tank, or dry wall construction, could be utilized to retain the material instead of the sheet piling. The possible beam and slab combinations are also numerous. Where teredo and limnoria are active, concrete piles and sheet piling are used. Its lightness makes for economy of concrete as well as of piles. The possibility of using a comparatively narrow apron without anchoring back is advantageous, where space is limited on account of existing buildings or where more waterway might be obtained by its use. It compares advantageously with any type of permanent construction now known, and when one considers the charges on timber construction, such as fire insurance, depreciation, and replacement charge, the heavy maintenance cost, and the frequent interference with (or even interruption of) traffic, the wonder is that we do not have more concrete wharves, where all other considerations are equal.

# Problems Relating to the Tile Drainage of Irrigated Lands

By H. C. MILLER *

Water for irrigation is usually obtained from some stream, reservoir, or artesian well and conducted by a canal along the upper side of the land to be irrigated, and distributed by a system of smaller ditches or laterals to the land below. The soil through which these waterways run is often loose and porous, and a considerable amount of water, sometimes as much as 50% or more, escapes by percolating through the loose soil. Some of this water finally finds its way into streams and basins, but that which remains as ground-water, gradually collects in the lower levels and eventually appears at the surface, destroying crops either by wetness or alkali and making the land worthless until these conditions are remedied.

For the average soil the proper depth of the plane of saturation should vary between 2 and 4 ft., the former figure for grain lands, pastures, and meadows, the latter for orchards and vineyards. In localities where the drainage is so poor that the ground-water rises above these limits, artificial drainage must be resorted to, in order to properly till the soil. The water table must be lowered to such a depth that the free circulation of air within the root zone will in no way be retarded or completely stopped.

In the arid West where the annual rainfall is but a few inches, almost all of it falling within a period of two or three months in the winter, one cannot rely upon calculations based on the precipitation within the period of average maximum precipitation, as the percentage of rainfall which reaches the plane of saturation varies greatly, depending upon the time of the year, the nature of the soil, and the conditions existing on the surface.

In other localities where the average annual rainfall does not exceed 38 in., experience has shown that one is safe in assuming that about all the water that a drain will be called upon to remove is ¼ inch in 24 hours.

Highly essential to the calculation of a successful drainage system is a contour map drawn to a scale large enough so all the data may be placed on it. Next determine the position of the outlet, and it is well at this time to interview the property-owners below the outlet, as the drainage water may have a serious effect if allowed to run on their land without first making proper provision for its distribution.

The source of the water which enters the land under consideration should next be determined, as very often the wet condition is not due to the leakage of ditches but rather to the accumulation of seepage which has percolated through the subsoil from higher land. To best secure this information, a series of borings should be made at intervals of 100 ft. or less, starting at the upper edge and working down. A fence-post auger is an excellent tool for this purpose, by means of which the position of the water table and the depth to hard-pan and gravel can be determined. In most places the water table will fluctuate between wide limits, reaching its maximum in winter or early spring.

Calculations in localities of little rainfall should be based on the rise of the plane of saturation within the period of average maximum rise, and field observations should generally extend over that period, which may be from one to four weeks.

The position of the test holes should be accurately plotted on the contour map with their elevations and other observed data. These preliminary examinations are essential; for all drains must in some manner reach the immediate source of water and cut it off. Having recorded all the data on the map, next draw in the lines of tile in their proper location to best serve the area to be drained.

*Consulting Engineer, Bishop, California.

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We are now prepared to establish the final grades and compute the size of tile required for each line. It is absolutely essential in fixing the grades on any particular line that the velocity therein does not exceed what is known as the 'critical velocity.' The reason for this is obvious, as the scouring action due to the velocity of the water will undermine the tile at the joints and reduce the efficiency of the drain, and ultimately result in its complete destruction. The 'critical velocity' for drain tile is about 3 ft. per second in light loose sandy soil to 8 ft. per second in heavy clay.

A uniform grade should be used from point to point, and where possible the velocity of the water should be maintained or increased as it flows toward the outlet, otherwise in checking the velocity, fine sand and silt are caused to settle, eventually clogging the line. The least permissible velocity in a drain of good construction should be 0.75 ft. per second, which is ample to remove the fine sand and silt but not the coarse sand and gravel which may find their way in through the joints. Drains in successful operation have been laid on as low a grade as ½ in. to 100 ft., but if possible the minimum grade should not fall below 0.1 ft. per 100 ft. Where a flattening of the grade is imperative,

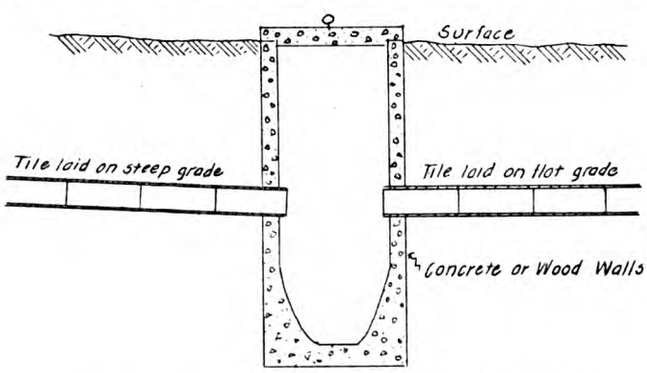


Fig I - Sand box connecting tile lines of steep and flat grade.

some arrangement such as shown in Fig. 1 should be used.

Where a lateral enters another drain, allowance must be made for a 'drop,' the amount of which should be in proportion to the size of the tile into which the branch discharges. These amounts have been tabulated in Table I.

TABLE I—DROP REQUIRED AT INTERSECTIONS OF TILE

| Diam. tile, inches. | Drop, feet. | Diam. tile, inches. | Drop, feet. |
|---|---|---|---|
| 4 | 0.19 | 14 | 0.60 |
| 5 | 0.20 | 16 | 0.70 |
| 6 | 0.25 | 18 | 0.80 |
| 8 | 0.35 | 20 | 0.90 |
| 10 | 0.40 | 24 | 1.00 |
| 12 | 0.50 | | |

After approximately roughing in the grades, calculate the area served by each portion of the system. This work should begin at the laterals and proceed toward the outlet; in this manner complete data are secured as to the exact duty required of each line of tile.

Table II gives the distances between laterals that have been found safe from experience.

TABLE II

| Description of soil. | Distance between laterals, feet. |
|---|---|
| Clay (hard) | 20– 40 |
| Clay (loose) | 30– 50 |
| Loam (heavy) | 40– 60 |
| Loam (sandy) | 50– 80 |
| Sand (fine) | 80– 125 |
| Sand (medium and coarse) | 150– 450 |
| Gravel | 500–1000 |

At Bishop, Inyo county, California, the average maximum monthly precipitation is about 0.90 in. or 0.075 ft., but experience shows that for the purpose of calculation one should double the amount within the period of average maximum precipitation, occurring usually during the winter months. This brings the figures for the average maximum monthly precipitation at Bishop up to 1.8 in. or 0.15 ft. The average maximum rise of the water table in the lowlands where drainage is required is 3 ft., and as the porosity of the soil varies from 20 to 35%, with a mean of 25%, the rise of three feet in the water table corresponds to a depth of 0.75 ft. on the surface, or five times the average maximum monthly precipitation. The rôle that seepage plays in this locality is thus apparent, and as the average daily precipitation is so small, we may safely omit it in our calculations and base all further computations on a rise of water table of 3 ft. Taking this rise as a basis, the quantity of water to be drained from one acre is 43,560 × 0.75 or 32,670 cu. ft., and

$$\frac{32{,}670}{30 \times 24 \times 60 \times 60} = 0.01260 \text{ cu. ft. per sec.}$$

Inversely, removing one cubic foot of water per second from the soil will drain approximately 80 acres, and a drain having a capacity of 8 cu. ft. per sec. would serve a section.

For a quick comparison of results and the selection of the most economical size of tile required, the writer has represented the results graphically in the accompanying diagram. By plotting the logarithms corresponding to the numbers in place of the numbers themselves, the curves assume approximately straight lines and the interpolation of results from the diagram is thus facilitated. The diagram is based on the average maximum rise of the water table of 3 ft., corresponding to five times the average maximum monthly precipitation of 0.15 ft., or a maximum daily precipitation of 0.06 inch.

Should the rise of the water table in any locality under consideration differ from that upon which the diagram is based, one has merely to multiply the actual drainage areas by a given factor; thus, for a rise of 2 ft. the areas are to be multiplied by $\frac{2}{3} = 0.66$ to give the proper diameter of tile required.

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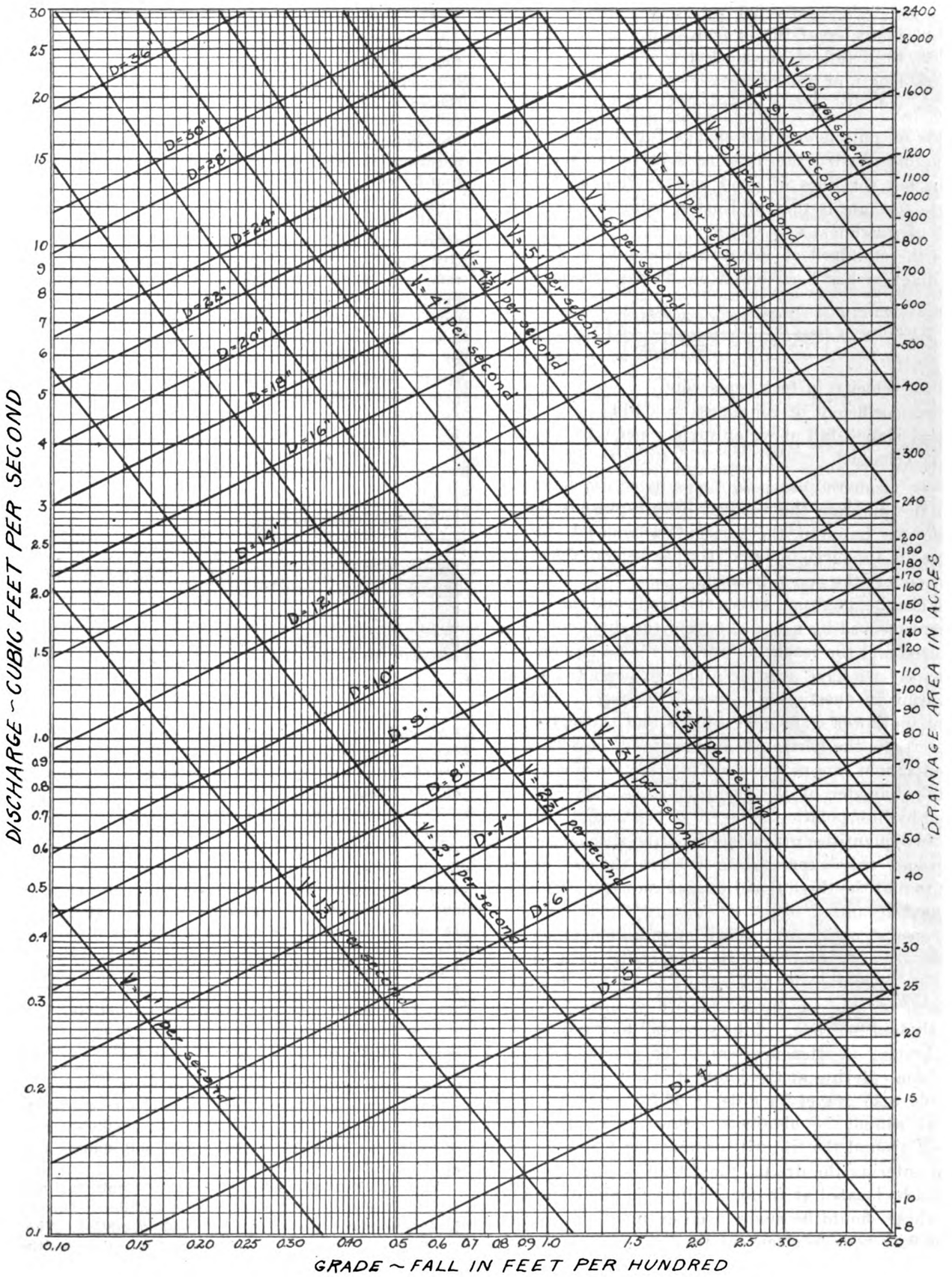
BASED ON KUTTER'S FORMULA $V = \left\{ \dfrac{\dfrac{1.811}{n} + 41.6 + \dfrac{0.00281}{S}}{1 + \left(41.6 + \dfrac{0.00281}{S}\right)\dfrac{n}{\sqrt{r}}} \right\} \sqrt{rS}$

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Velocities are generally calculated from Poncelot's formula:

$$V = 48\sqrt{\frac{df}{l + 54d}}$$ in which

$d$ = diameter of tile in feet
$f$ = total fall of line in feet
$l$ = length of line in feet
$v$ = velocity in feet per second

This formula is accurate enough for all drains where the actual construction is to be done by inexperienced labor, but for lines of good construction, a more accurate formula is that of Kutter, using for the coefficient of roughness $n = 0.014$.

As the standard of construction should be the best, the diagram has been based on Kutter's formula:

$$v = \left[\frac{\frac{1.811}{n} + 41.6 + \frac{0.00281}{s}}{1 + \left[41.6 + \frac{0.00281}{s}\right]\cdot\frac{n}{\sqrt{r}}}\right]\sqrt{rs}$$ in which

$v$ = velocity in feet per second
$n$ = coefficient of roughness = 0.014
$s$ = slope—fall of water surface per unit length of channel
$r$ = mean radius = ¼ times inner diameter

In the diagram the vertical lines represent the fall in feet per hundred, the horizontals from left to right represent discharge in cubic feet per second, those from right to left the acres drained.

To use the diagram: Given the grade and the number of acres served by a drain, to find the diameter of tile required and the resultant velocity. As a specific case, let us say we have a grade of 1.5 ft. per hundred and the drain in question is to serve 300 acres. Find 1.5 along the lower margin, trace this line vertically until it intersects the horizontal line representing 300 acres. The diagonal line nearest this intersection gives 12 in. as the diameter of the tile with a velocity which is found by interpolation to be 4.7 ft. per second. Having any two quantities given (acreage and discharge being the same, only expressed in different terms), we are able to find the three remaining unknowns by referring to the diagram.

The construction of drains is often accompanied with much difficulty and expense, especially in saturated soil. In crossing soft spots there is no better method than to lay the tile on boards which have been previously laid to grade. If the sides fail to stand, shoring and bracing is often necessary. To prevent sand and silt from entering at the joints it is advisable to cover the tile with gravel for a depth of from 6 to 12 in. If gravel cannot be obtained, straw or weeds packed closely around the tile will prevent much fine material from entering the drain. Sand traps similar to Fig. 1 should be located at frequent intervals along the lines, and these should be made large enough so a man can enter with rods to clean out the lines in case they become clogged.

# Industrial Progress

## GENERAL ELECTRIC CO. EXHIBIT, TRANSPORTATION BUILDING, PANAMA-PACIFIC INTERNATIONAL EXPOSITION

The exhibit of the General Electric Co. in the Transportation building at the Panama-Pacific International Exposition is extensive and comprises electric locomotives for various classes of service, including steam railroad electrification, railway motors, and all kinds of apparatus and accessories for electric railways, signal accessory electric devices, electric apparatus and equipment for railway shops, electric illumination for cars and shops, etc.

One interesting exhibit is the electric locomotives, shown in the illustration, coupled together ready for shipment across the continent. The Butte, Anaconda & Pacific locomotive is one of four units which have recently been built for this road and is a duplicate of the original seventeen units put into service in 1913. These are the first 2400-volt, direct current electric locomotives ever built. Each unit weighs 80 tons. Two are, however, coupled together for freight service to form a locomotive weighing 160 tons. The combination freight locomotives are hauling main-line trains of 4600 tons at a speed of 16 miles per hour against the ruling grade of

ELECTRIC LOCOMOTIVES.

0.3% and at 21 miles per hour on level tangent track. The two passenger locomotives, operating as single units on this system, are geared for a maximum speed of 45 miles per hour on level tangent track.

The freight traffic on this road consists largely of the transportation of copper ore from the mines at Butte to the smelters at Anaconda. The initial electrical equipment was intended for handling annually about 5,000,000 tons of ore, besides a large amount of mine supplies and an extensive freight and passenger service consisting of eight trains per day between the terminal cities. On account of the diversion of about 3000 tons of ore per day from the smelters at Great Falls to those at Anaconda, an increase of approximately 25% is anticipated in the tonnage to be hauled during the coming year, necessitating the four additional locomotives.

Based on six months' steam and electric operation, a comparison shows a total net saving for the latter of more than 20% on the investment or total cost of the electrification, with an increase in tonnage per train of 33%, a decrease in the number of trains of 25%, and a saving of 30% in the time required per trip. This electrification includes about 26 miles of main line, comprising, with yards and sidings, a total of about 90 miles on a single track basis.

A 60-ton electric locomotive of the type built for interurban freight and passenger service is on exhibit. This machine is designed for both 600 and 1200-volt operation. The cab is of all-steel construction and is divided into three sections, the central operating cab containing the controller and other ap-

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paratus that should be within immediate reach of the engineer, and the two-end steeple-back cabs containing the auxiliary electrical apparatus. The motor equipment consists of four GE-251 commutating pole motors, one mounted on each axle. These motors are arranged for forced ventilation from a blower in the cab. The well-known type M multiple unit control is used and combined straight and automatic air-brakes are provided. The trucks are the equalized type and conform to MCB standards.

There is also a 16-ton electric locomotive of similar design with steeple-back end cabs for industrial freight and switching service. It is equipped with two commutating pole ventilated motors. Two types of mining electric locomotives will be shown. One is a large 20-ton trolley type equipped with three motors and the other is a 6-ton combination trolley and storage battery locomotive equipped with two motors, all of the commutating pole type.

The General Electric Co. has adopted the commutating pole ventilated type of motor as standard for practically all multiple unit railway car equipments. Motors of this construction have a greatly increased service capacity when compared with motors of the closed type having the same hourly rating, on account of the positive circulation of air that is maintained throughout the interior by the system of self-ventilation. The display of these motors comprises GE-200, 203, 201, 222, and 247, all 600-volt motors of 40, 50, 65, 140, and 35-hp., respectively; types GE-233 and 240, 600/1200-volt motors of 75 and 85 hp., respectively; GE-239, 140-hp., 2400-volt motor; and GE-245, 60-hp., 600-volt motor exhibited exploded to show the construction.

A storage battery platform truck and also a battery truck crane for moving freight in warehouses, factories, and on docks is exhibited. There is a portable air-compressor set, for use around factories, the compressor being fitted with a glass cover and the interior illuminated to show the operation. This same type GE-27 air-compressor is employed with air-brake systems, one of which will be displayed mounted on a rack the same as installed on a car, with all the valves and accessories for combined straight and automatic operation.

One of the most interesting features of the traction exhibit is the two single-end type MK control equipments, each mounted on a separate rack in the usual manner of installing for service. The exhibition racks, which occupy a floor space about equal to that required for a small city car, are placed end to end with control jumpers and air-brake hose connections for train operation. Each control equipment consists of a master controller, contactor box, etc., completely wired up for operation of two GE-247 motors, which are mounted on a truck beneath the rack. These equipments also include completely installed straight and automatic air brakes, with CP-27 air-compressor governor, valves, etc., in actual operation. The motor trucks are equipped with third rail shoes.

Another exhibition rack contains a complete type M multiple unit control designed for three-speed operation in city service. The controller exhibit includes the standard K-35, K-36, K-51, and K-201 types. The last named controller is designed for three running positions and is suitable for frequent stop city service. A complete assortment of line material is grouped on a large frame, many of the devices in the same manner as installed in actual service.

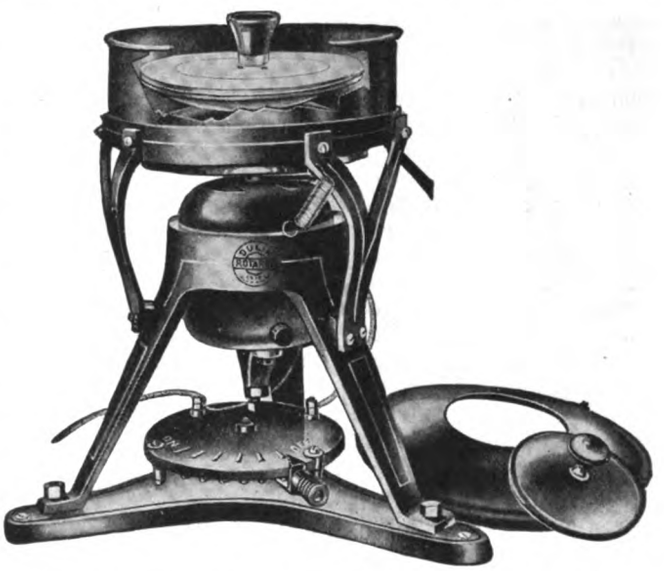
A large number of separate valves, contactors, governors, fuse boxes, rheostats, switches, lightning arresters, and other devices entering into car equipment form part of the exhibit. Forged steel treated gears and also cast steel split and solid gears and pressed steel gear cases for city, suburban, and interurban service are shown, as well as several grades of forged steel treated pinions and pinion pullers. A display of railway lamps demonstrates effectively systems of lighting cars with modern Mazda lamps. Automobile lamps and accessories are also included. Shadow boxes and photometric curves demonstrate the relative value of the illuminating units. There is likewise a complete line of both incandescent and luminous arc head lamps, with semaphore lenses and parabolic reflectors, for city, suburban, and interurban service.

The line of signal accessories includes transformers, vacuum, and multi-gap lightning arresters, motor-generator sets, switchboards, instruments, etc. Other interesting apparatus of various kinds are a mercury arc rectifier of the standard type for battery charging, an electric arc welding outfit, a complete line of car fans, a new high frequency oscillator in operation testing insulators, a full line of insulators, a new multi-recorder for attaching to switchboards to keep automatically a record of the time of the manipulation of the various switches, an 18-in. search-light projector similar to those used for illuminating the exposition grounds, complete line of circuit breakers, etc.

An attractive and instructive feature of the exhibit is the several hundred illustrations which a stereomotograph projects automatically on a large ground-glass screen. These cover the range of modern traction developments, made from actual photographs taken in various parts of the country, and show important applications of recent railway equipment in city, interurban, and heavy electrification service, as well as many typical installations of new apparatus in large power plants and substations.

## THE DULIN ROTAREX

The Dulin Rotarex is a centrifugal machine designed for extracting bituminous aggregates and is especially adapted for analyzing paving and road compounds, such as bitulithic macadam, and ordinary surface mixtures. A simple speed-changing switch on the base accommodates the machine to various mixtures. Non-inflammable solvent is used. The aluminum bowl, 3½ inches in diameter, holds as much as 50 grams at a charge. The bowl is fitted with a hollow axle which



fits snugly over the shaft. A plate glass top covers the bowl, which permits observing the sample at all times. A felt paper ring, 1 in. wide, is placed between the plate-glass cover and edge of aluminum bowl. The cover is held firmly in place by a funnel shaped screw which engages with the threaded hollow axle. Through this funnel-shaped screw the solvent is added as needed. A special feature is the small hole extending through the screw, which prevents the receptacle becoming air-bound while being filled. The shaft of the motor projects into a cylindrical copper shell, the bottom of which is so inclined as to drain through a spout. The copper bowl is fitted

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with a two-piece cover, the smaller piece being removed when adding additional solvent.

Tests have shown that an inexperienced operator can do the work, formerly requiring three and one-half hours, in six minutes. Samples can be taken from mixers or wagons, and their constitution determined before dumping and without delaying the work. Hence, exact information can be obtained at every step, proportions checked, and weighings verified without loss of time or risking faulty work. The states of New York, Pennsylvania, Maryland, West Virginia, and New Jersey and many of the largest cities rely entirely on this machine.

The Rotarex is small and can be easily carried from place to place. It is driven by a Westinghouse Electric high-speed motor which will operate on any lighting circuit. It is marketed by the Braun Corporation, Los Angeles, and the Braun-Knecht-Heimann Co., San Francisco.

## PELTON WATER WHEEL CO.'S EXHIBIT AT P. P. I. E.

In the Palace of Machinery, one of the most complete installations and most comprehensive exhibits, is that of the Pelton Water Wheel Co. and its co-exhibitors. Water-power development is such an essential factor in the economic life of the coast, that it was felt by the exhibition authorities that a complete working exhibit showing all the phases of hydraulic installations would be of prime interest. The general plan of this exhibit may be divided into three parts. The first, an operating replica of a high-head hydro-electric installation; the second, an operating replica of a low-head turbine installation; the third, a display of Pelton equipment as designed and built for use in various classes of installations. These three phases of the exhibit will be explained in some detail.

### Diesel Engine

It being obviously impractical to secure high-head natural flow, this is provided in the first section of the exhibit by means of a Pelton-Doble turbine pump, which will be driven by a 150-hp., 6-cylinder, submarine type Diesel engine, manufactured by the New London Ship & Engine Co. The Pelton-Doble turbine pump is of the single-stage type, designed to pump against an effective head of 300 ft. In order to secure this head with a single-stage, it is obvious that the speed must be materially higher than 350 r.p.m., the speed of the Diesel engine. In order to secure this speed, a herring-bone speed increasing gear, built by the Falke Gear Co., is interposed between pump and engine, in lieu of standard flexible couplings. The guaranteed efficiency of this type of gear is 98½%. This speed increasing gear is direct connected to the pump, which it drives at a speed of 1800 r.p.m. The high-pressure pump draws its suction water from a large sump, from which the entire supply of water for the operating exhibit is taken and again returned. In the discharge line of the Pelton-Doble high-pressure pump, is installed a Venturi recording meter, providing an accurate and continuous measurement of its output.

### Tangential Wheel

The effective pressure of the pump discharge is measured by means of Crosby indicating gages; these being installed as well, on the suction side of the pump. By means of a Venturi meter and the suction and discharge gages, all of which are carefully and specially calibrated for use in this work, an accurate determination of the output may be obtained. The water from the pump is discharged directly into a Pelton-Doble tangential wheel. This wheel represents the latest type of construction in tangential work and is of the overhung type, direct connected to a water-wheel type, 75-kw., 300-r.p.m., direct-current generator, manufactured by the General Electric Co., and part of its co-exhibit. Observation windows are placed in the base of this wheel, so that the action of the jet as it impinges on the buckets can be carefully observed. The regulation is maintained within very close limits, by means of a Pelton-Doble oil pressure governor, actuating a needle nozzle with auxiliary relief valves, all of the Pelton-Doble type. The governor is of a different general arrangement from any type of governor that has been employed with tangential wheels, being mounted directly on the base of the wheel, making the whole unit self-contained.

### Electrical Equipment

The electric energy generated by the 75-kw. machine is carried to the switchboard, which contains a complete set of indicating and curve drawing instruments, as well as recording meters, so that every possible check and analysis of the energy may be made. This switchboard is further arranged to provide facilities for frequent calibration of the instruments, should it be desired at any time during the course of the fair. It is the intention to have this exhibit thoroughly tested by engineers who care to interest themselves in such work, and should such engineers care to check the calibration of any of the measuring equipment, arrangements have been made to facilitate this work.

From the switchboard the electric power is conveyed to the mains of the Panama-Pacific Exposition and is utilized as part of the energy supplied on the grounds.

### Deep Well Pump

The second section of the Pelton Water Wheel Co.'s exhibit in conjunction with its co-exhibitors, consists of a Pelton-Doble high-pressure, high-capacity, vertical type deep-well pump, which is driven by means of a 110-hp., 1760 r.p.m., alternating-current vertical pump motor, built by the Westinghouse Electric & Manufacturing Co., and part of its co-exhibit. The energy for operating this motor is taken from the alternating-current high-tension mains of the Exposition company. The motor is of a design especially worked out to meet the requirements of vertical turbine pumps. Crosby indicating gages are provided on both the suction and discharge sides of this pump, thus enabling accurate determinations of suction and pressure head to be made. Further, a recording Venturi meter is placed in the discharge line; this, as well as the Venturi meter measuring the water input of the tangential water-wheel unit, being a co-exhibit with the Builders Iron Foundry, of Providence, Rhode Island. After passing the recording Venturi meter, the water under a pressure equivalent to a head of 50 ft. (this being obtained by the single-stage runner of the deep-well pump), is discharged into a Pelton-Francis high specific speed turbine. This turbine is of the most modern construction and is particularly designed to show the very marked strides which have been made in the design of turbines during the past few years. The speed regulation of this turbine will be accomplished by a Pelton automatic oil pressure governor of the self-contained type.

### Governors

At this point it is well to mention that a very interesting feature of the exhibit is the special equipment provided for maintaining a supply of oil under proper pressure for operating the automatic governor of both the turbine unit and the tangential wheel unit. A self-contained and automatically operating water-wheel driven Pelton-Doble rotating oil pump is installed, which delivers the oil under suitable pressure to the air-pressure accumulating tank. The oil pump is driven by a small, especially constructed Pelton-Doble tangential wheel of the over-hung type, being direct connected thereto. The entire unit is so designed that the wheel which drives it will automatically start, in the event of the oil pressure dropping below a certain predetermined point, while after the pressure has reached the point it is desired to maintain, the water-wheel and pump are automatically stopped. The cycle of operation is self-contained within the oil system and has no connection with the water-wheel load, its operation being predicated entirely on the demand for oil as produced by the governor in its regulation of the water-wheel driven units

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Referring to the Pelton-Francis turbine, which is of the horizontal type, this is direct connected to a 30-kw. 1400-r.p.m. direct-current generator, which is also part of the co-exhibit of the Westinghouse Electric & Manufacturing Co. The electric energy from this generator, after passing through the switchboard and being measured and recorded by suitable instruments and meters, as mentioned in conjunction with the generator of the tangential wheel unit, is then delivered to the service mains of the Exposition.

### 20,000-HP. TURBINE

The third section of the exhibit consists of a number of Pelton products arranged to show general design and construction. The principal item of this exhibit is a 20,000-hp. single-discharge runner, Pelton-Francis turbine, designed and built for direct connection to a 15,000-kva. alternating-current generator. This unit is designed to operate at 360 r.p.m. under an effective head of 500 ft. This turbine will be set up complete except that the runner will be left out. The runner will be mounted on a special stand so that its design and its many special features can be displayed. The governor of this unit is of the direct motion type, being built integral with the turbine. It exerts a cross-head pull of 40,000 foot pounds. Some idea of the duty which this governor performs can be obtained when it is taken into consideration that the total output of 20,000 hp. is controlled by a peripheral movement of the guide vane shifting ring somewhat less than four inches.

There will also be on exhibition a deflecting needle nozzle and the tangential wheel which it drives, both of which have been designed for the development of 10,000 hp. under an effective head of 1350 ft. This Pelton-Francis turbine and the deflecting needle nozzle and tangential wheel, are placed on exhibition through the courtesy of the Pacific Gas & Electric Co., for whom these have been built on contract.

Among the other interesting features of the exhibit will be a number of smaller types of Pelton wheels, including the well known Pelton-Doble laboratory motor, an exact duplicate of the laboratory installations that have been made in many of the prominent technical schools of the world.

### HYDRAULIC GIANTS

There will also be a number of the Pelton ball-bearing hydraulic giants on exhibition. These giants are a great improvement over the old giants used during the period when hydraulic mining in California was in its heyday. These giants now meet a wide range of use in various classes of construction work, such as the building of hydraulic dams, the terracing of hills, and digging of trenches for various classes of engineering undertakings. Furthermore, a considerable portion of the tin output of the world is thus washed out of the placer workings in the Straits Settlements, as well as many portions of Alaska and Colombia.

## ROCMAC PAVEMENT AT VICTORIA, BRITISH COLUMBIA

Rocmac pavement has been used on several important highways in the Northwest, among these being a road containing about 12,000 sq. yd. at Sumas, Washington, and also the National Park highway at Banff, Alberta. When the question of paving the Colwood road at Victoria, between Parson's bridge and the Colwood hotel, came up, the use of Rocmac pavement was decided upon. The length of the road is 1.14 miles, the width 21 ft., and thickness of finished pavement 6 in. In all, 15,602 sq. yd. of pavement was laid.

The specifications called for rolling the subgrade with a 10-ton steam roller, and the removal and replacement of all spongy material. The bottom course was composed of 4½ in. of crushed rock or gravel, or a mixture of the two, all of it passing a 3-in. ring and being retained on a 1½-in. ring. It was sprinkled with water and rolled with a 10-ton roller. For the matrix, five gallons of Rocmac solution was added to 9 cu. ft. of limestone screenings (from ¼ in. down to dust), containing not less than 85% calcium carbonate. After mixing, either by hand or with a concrete mixer, the matrix was spread evenly over the bottom course, the given quantity being sufficient for eight square yards of surface. Upon this matrix was spread a 3-in. layer of crushed rock or gravel ranging in size from two to three inches. The surface is then rolled until it shows no sign of yielding to the roller, and until the matrix, which has gradually risen to the surface, is uniform over it. Water may be used to prevent the roller picking up the surface rock, and to assist in the uniform distribution of the matrix.

VIEW OF COMPLETED ROAD.

The work on the Victoria road was started in June and finished in the early part of October. The entire road was done by day labor, all labor and material being paid for by the provincial government. The particular conditions under which the work was done tended to make the cost unusually high. It was necessary to open up a quarry simply for this work, and the total cost included a large amount of grading, in addition to the surfacing. Nevertheless, the average cost of the work was only $1.093 per square yard.

At no time during the construction was the road entirely closed to traffic, which sometimes amounted to 1500 vehicles per day.

# Hints on Practice

## CONCRETE POSTS FOR MAIL-BOXES

The accompanying picture illustrates a novel but thoroughly practical use of concrete. Wooden posts are subject to rapid decay at the ground level, where alternate wetting and drying takes place, and to avoid the necessity of renewals and repairs the concrete post was made.

A simpler post and one easier to make would be as economical. The form for casting a post of this kind is shown below. The post should be about 7 ft. long. Planted at a depth of 3 ft. this would leave the box at a convenient height for the delivery or extraction of mail. The form, as shown in the drawing, is simply a three-sided box providing for a post 6 in. square. The form is placed on the ground in horizontal position, with open side up, and filled with well tamped concrete to the depth of about 1 in. Then ⅜-in. reinforcing rods are placed at either side, leaving about 1 in. space between each rod and the side of the form. The box is then filled to within 1 in. from the top and two more reinforcing rods

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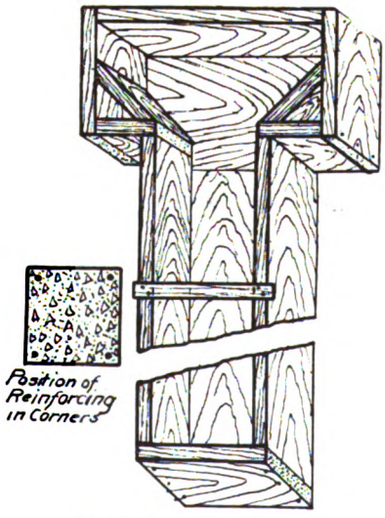
are placed on the concrete. The form is then filled to the top and the concrete struck off. The rods may go straight from the bottom to the top of the post, as it will not be necessary to curve them outward at the bracket.

The form or mold may be made with one or more braces

CONCRETE MAIL BOX POST.

nailed across the upper or open side to prevent the sides from spreading when the concrete is tamped. The bracket effect at the top is obtained by inserting extra pieces of wood at the corners, as shown. The post may also be made in other shapes.

To provide for fastening the mail-box to the post, bore two




FORM FOR CASTING POST.

or perhaps four holes through the board at the top of the form. Insert the bolts in these holes with the heads down. The bolts will be imbedded in the concrete when it is placed, and when the form is removed the threaded ends of the bolts will project slightly above the top of the post. Holes cut in corresponding position in the bottom of the mail-box will permit the bolts to pass through.

Mix the concrete in the proportion of 1 part portland cement, 2 parts sharp clean sand, and 4 parts crushed stone, ranging from ½ to 1-in. size. Allow the concrete to remain in the forms for at least 24 hours. When the post is removed, protect it from freezing, or if made in summer, from hot winds and sun. Wet it thoroughly for a week or ten days after removing it from the forms.

# Engineers' Note Book

## HORSE-POWER DIAGRAM FOR BELTS

The accompanying diagram may be used for calculating the width of belt required to transmit a given horse-power, and similar problems. From the pulley diameter at the left, trace horizontally to the diagonal r.p.m. line; thence vertically to

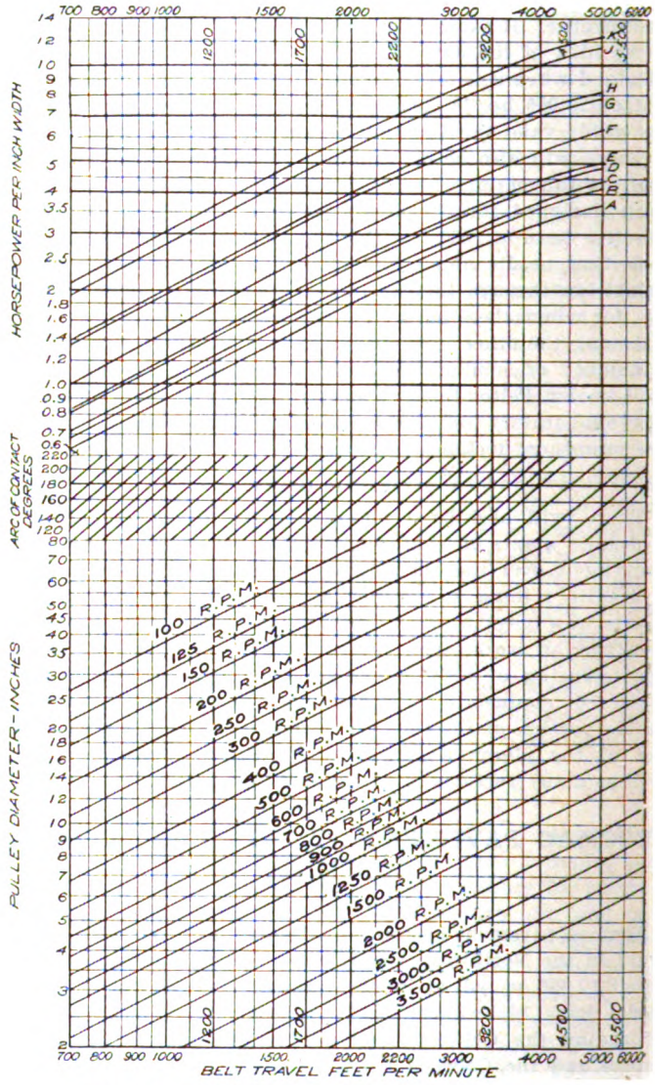



DIAGRAM FOR CALCULATING HORSE-POWER OF BELTS.

the 180-degree horizontal; thence along the diagonal to the horizontal for the arc of contact; thence vertically to the curve for the kind of belt to be used; thence horizontally to the horse-power scale. Multiply by the width in inches to obtain the horse-power, or divide the total horse-power transmitted by the horse-power scale reading to obtain width of

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belt required. The pulley diameter and speed should be so chosen as to give a velocity not over 4500 ft. per minute.

In the diagram the line

*A* = single leather on pulleys under 8 in. diameter, also 3-ply balata.

*C* = single leather on pulleys 8 to 36 in. diameter.

*D* = single leather on pulleys over 36 in. diameter, also 3-ply rubber.

*E* = 4-ply canvas.

*F* = double leather on pulleys under 14 in. diameter, also 6-ply canvas.

*G* = double leather on pulleys 14 in. diameter and over, also 8-ply canvas.

*H* = ¾-in. link leather, also 6-ply rubber.

*J* = triple leather, also 1-in. link leather, also 8-ply rubber.

*K* = 10-ply canvas.

The following values should be used for the allowable tension on belts: single leather, 60 lb. per inch wide; double leather, 105 lb.; triple leather, 150 lb.; rubber, 3-ply, 45 lb.; 4-ply, 65 lb.; 5-ply, 85 lb.; 6-ply, 105 lb.; 7-ply, 125 lb.; 8-ply, 145 lb.; canvas, 4-ply, 40 lb.; 6-ply, 60 lb.; 8-ply, 80 lb.; 10-ply, 100 pounds.

# Book Reviews

THE 'MECHANICAL WORLD' POCKET DIARY AND YEAR BOOK FOR 1915. P. 264, with index and diary. Norman Redington Co., Baltimore, Maryland. For sale by *Mining Press*, San Francisco. Price, 50 cents.

THE 'MECHANICAL WORLD' ELECTRICAL POCKET BOOK FOR 1915. P. 202, with index and diary. Norman Redington Co., Baltimore, Maryland. For sale by *Mining Press*, San Francisco. Price, 50 cents.

For over twenty years these two small publications have been issued annually to the great satisfaction of many engineers. While they are necessarily not so comprehensive as the larger pocketbooks, selling for several times the price, there is no doubt that the purchaser of these volumes gets his money's worth. The diary is the more general work and contains a large amount of useful information for the mechanical engineer, including definitions of units, working laws and formulae, and many diagrams and tables. The electrical pocketbook contains similar data for the electrical engineer. Each book contains the usual mathematical tables and a diary for 1915.

VALVE GEARS. By Charles H. Fessenden. P. 168. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining Press*, San Francisco. Price, $2.

One of the most important departments of engine design is that relating to the design of valve gears. The present volume deals only with steam-engine valves. After an introduction discussing the general subject of valves and the other parts of the steam engine which affect their design, the Zeuner and Bilgram diagrams are taken up and their use in the solution of problems of design explained. Forms of slide valves, shaft governors, and valve setting both by measurement and by the indicator diagram are next discussed. The design of slide valves is considered, including those with riding cut-off and pump valves. The remainder of the book is taken up with a discussion of various special types of gearing; reversing gears, the Corliss valve, and poppet valves being taken up in order.

STRUCTURAL STEEL DRAFTING AND ELEMENTARY DESIGN. By Charles D. Conklin, Jr. P. 151. Index. John Wiley & Sons, Inc., New York. For sale by *Mining Press*, San Francisco. Price, $2.50.

Of the six books which have been published in America during the past twenty years upon this subject, the present volume is the most complete and up to date in its treatment of the preparation of shop drawings for structural steel work. It is intended to be of greater assistance in the design of bridges than in that of towers, mill buildings, and office buildings. The analytical treatment of the theory involved is illustrated by numerous figures. There are a number of tables of fittings as well as useful diagrams, and the author makes frequent reference to builders' handbooks and other standard works. General specifications for steel railway bridges are given in the appendix. The book will be of value both to the student and the practising engineer.

PLAIN AND REINFORCED CONCRETE ARCHES. By J. Melan. Translated by D. B. Steinman. P. 153. Index. John Wiley & Sons, Inc., New York. For sale by *Mining Press*, San Francisco. Price, $2.

The author of this work is well known as the inventor of the Melan system of arch construction. The book discusses the determination of stresses in the various types of arches, hingeless, one-hinged, two-hinged, and three-hinged, together with continuous spans. Use is made of both the graphic and the analytic method. The proportioning of both plain and reinforced concrete arches is then considered. An example is then given of the complete design of a reinforced concrete arch of the Melan type, by both the graphic and the analytic method. A chart is appended for the design of concrete sections with double reinforcement. The translator has added a complete index of the notation used by the author, which will be found very useful.

MASONRY. By Malverd A. Howe. John Wiley & Sons., Inc., New York. P. 155. Index. For sale by *Mining Press*, San Francisco. Price, $1.50.

While there are a number of volumes of considerable size dealing with masonry both thoroughly and well, it is difficult to find a book giving a condensed but fairly general treatment of this subject. It is to fill this field that the present volume has been written. After considering the various materials for masonry, stone, brick, and concrete masonry are taken up in order, all discussion of reinforced concrete being omitted. A chapter on specifications follows, and the book closes with a list of about three or four pages of references, which latter is a fairly complete bibliography of the most useful books and articles upon the subject.

WORKING DATA FOR IRRIGATION ENGINEERS. By E. A. Moritz. John Wiley & Sons, Inc., New York. P. 388. Index. For sale by *Mining Press*, San Francisco. Price, $4.

While a little space at the beginning of the book is devoted to irrigation surveys and the design of irrigation systems, and the last chapter contains forms for most of the specifications which would be needed on irrigation work, most of the book is devoted to mathematical diagrams and tables. Besides those that are found in nearly every engineering pocket-book, there are many tables of the hydraulic properties of various types and sections of canals, flumes, etc. It is unfortunate that the book, which would be useful to many irrigation engineers as a pocket-book, is not published in pocket-book size.

ENGINEERING OFFICE SYSTEMS AND METHODS By John P. Davies. P. 524. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining Press*, San Francisco. Price, $5.

There are many subjects with which the young technical graduate finds he should have some acquaintance, which were not included in his college course. There are also numerous details in the work of the older engineer, about which he is well informed but which he is likely to overlook unless reminded of their existence. The present volume treats several subjects in both these classes more thoroughly than any work

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which has appeared heretofore. The first chapter after dealing with foundation testing and stream gaging, gives complete outlines of the main divisions that should be covered in reports on various engineering projects. Chapter II is intended mainly for use in the drafting room and contains outlines for the design of the principal classes of structures together with rules for checking drawings. There is also a brief but useful summary of the principal causes for the failure of engineering structures. Chapter III deals with specifications and includes a number of useful outlines of specifications, which are sufficiently in outline to prevent their abuse by the 'specification fiend.' The next chapter deals with obtaining quotations on standard materials, from steam engines to firebrick, and should be of assistance to many engineers and, indirectly, to machinery salesmen. The chapters on 'Purchasing-Office Methods' and 'Forms on Cost-Keeping and Estimating' while containing much valuable material, include but little that is distinctly new either in subject matter or treatment. The next chapter contains directions for sampling, inspection, and testing. Chapters VIII and IX, on 'Domestic and Export Shipping,' contain much valuable information concerning a subject of which many engineers are, unfortunately, almost entirely ignorant. The next chapter, concerning progress charts, etc., is similar in treatment to discussions of this subject in other books. Chapters XI and XII take up filing systems both for the office and the drafting room. The final chapter contains considerable miscellaneous information pertaining to the field of the book, but which was not included in the previous chapters.

# Recent Publications

RAILWAY ECONOMICS, A COLLECTIVE CATALOGUE OF BOOKS IN FOURTEEN AMERICAN LIBRARIES. The Bureau of Railway Economics, Washington, D. C. P. 446. The libraries mentioned include the principal university libraries and several other public collections. All publications relating to railway economics are listed, under various subheads, and the particular libraries in which they may be found noted.

OFFICIAL RAILROAD MAP OF CALIFORNIA. The Railroad Commission, San Francisco, California. A complete map of the state showing railroads, state highways, pipe-lines, government reservations, and similar information. An index of the cities, towns, and railroad stations is included. The main map is on a scale of 15 miles to the inch, and there are insert maps of the vicinity of San Francisco, Los Angeles, and San Diego on a scale of 3 miles to the inch.

PETROLEUM INDUSTRY OF CALIFORNIA. Map Folio accompanying *Bulletin* No. 69. California State Mining Bureau, Ferry building, San Francisco, California. Prepared by R. P. McLaughlin, assisted by C. A. Waring. This folio contains the maps and other large drawings illustrating the report that the Mining Bureau has prepared on the petroleum industry. There are 18 plates. Plate I shows a correlation of the geological formations in various parts of the Coast range, together with photographs of the characteristic fossils. Plates II to V are geological maps covering practically all the developed fields and the intervening territory, on scales from one to two miles to the inch. Plate VI shows a number of geological cross-sections in Monterey and San Luis Obispo counties. Plates VII to X and XII to XV are civil maps of the various fields on scales from one to three inches to the mile. Ownerships, wells, pipe-lines, and other improvements are shown with considerable accuracy. Plate XI shows the surface contours and approximate underground contours of the oil sand in the Midway and Sunset fields. Plate XVI gives plans and specifications of standard and rotary drilling rigs, and Plate XVII does the same for a concrete-lined earth reservoir. Plate XVIII is a small-scale map showing the various fields and the pipe-lines leading from them.

# Construction News Summary

**Condensed From Our Daily Construction News Service.**

### ARIZONA

**FORT HUACHUCA**—Contract for erection of buildings at Fort has been awarded to J. M. Sparks, Douglas, at $191,630.

**GLENDALE**—Municipal water system will be constructed. J. B. Girand, engineer.

**HIGLEY**—Queen City Power & Water Co. will install irrigation system for about 25,000 acres of land. Work will include drilling wells and installing pumps. John Schrock, Wichita, Kansas, and C. H. Rittenhouse, Phoenix, are interested.

**HUNT**—Charles Stokes and F. H. Church are considering irrigation system for land along Colorado river. Work will include large dam in this vicinity.

**KELTON**—Mascot & Western railroad will construct line to mines of Mascot Copper Co., about 35 miles. John A. Street, 1611 Harris Trust building, Chicago, is interested.

**PHOENIX**—Allis-Chalmers company has been awarded contract for furnishing centrifugal pumps for water works at $2400. ——It is proposed to install new pumping system of 3,000,000 to 5,000,000-gal. capacity at municipal water works. V. A. Thompson is superintendent.——Falls Power & Electric Co. will construct transmission line from Arizona Falls power plant to supply several irrigation pumping plants.——Building inspector H. J. Mann has prepared plans for two-story concrete fire station. Bids will soon be asked for furnishing high pressure auto fire-pump costing $9000, and aerial truck costing $12,000. ——Irrigation system for Casa Grande region involving pumping plant on Gila river and 20-mile pipe-line is being considered. C. M. Shannon is interested.

**PRESCOTT**—A. W. Wilson has been awarded contract for grading streets.——Arizona Power Co. is considering construction of three miles of 45,000-volt transmission line and a substation at Carliste with an output of 2000 hp. M. V. Watson is manager.

**TUBA**—Contract for construction of substructure for steel highway bridge over Moencopi wash has been awarded to Pueblo Bridge Co., Pueblo, Colorado, for $3061, and contract for superstructure to Joliet Bridge & Iron Co., Joliet, Illinois, for $2680.

**TUCSON**—Arizona Asphalt Paving Co. has been awarded contract for improving Toole avenue and other streets as follows: 15,340 sq. yd. bitulithic pavement at $2.195, 16,452 sq. ft. sidewalk at 15c., 2092 lin. ft. concrete curb at 60c.——Masons will erect building costing $65,000. H. C. Trost, El Paso, architect. ——W. D. Lovell, Minneapolis, has been awarded contract for erecting two government hospitals; one here and the other at Pima, at $14,466 each.——Contract for construction of Toole avenue and 10th Street electrical conduits has been awarded to Beotteger & Avery for $1471.——Two-story reinforced concrete city hall will be erected. Sidney Mashbir is architect.——F. H. Brackett and Colin Cameron will install electric light plant at Casa Grande, costing $100,000.

**WEBSTER**—Magna Copper Co. has awarded contract to McArthur Bros., 11 Pine street, New York, for constructing railway from Superior. Length about 30 miles.

**WILLIAMS**—Williams Water & Electric Co. will commence construction in June by day labor of reinforced concrete dam containing about 16,000 cu. yd. concrete.

### CALIFORNIA

**ALPAUGH**—Irrigation district covering 9000 acres in this vicinity has been organized. J. L. Adams has been elected treasurer.

**ARMONA**—Trewhitt & Shields, Fresno, have been awarded contract for erection of packing-house for $20,300. Building will be 2½ stories high and will have asphalt floors.

**ATWATER**—Owners of about 10,000 acres in this vicinity are considering formation of drainage district. George S. Bloss, Sr., and A. Clough are interested.

**AUBURN**—City trustees have decided to pave Main street under Vrooman act.

**AZUSA**—Following contracts for construction of water system have been awarded: Laying pipe, to Mesmer & Rice, 230 Marsh-Strong Bdg., Los Angeles, at $5900. Furnishing cast iron pipe to American Cast Iron Pipe Co., at $14,846.80. Furnishing riveted steel pipe to American Steel Pipe & Tank Co., Pacific Electric Bdg., Los Angeles, for $1200. Furnishing valves to N. O. Nelson Mfg. Co., 439 East 3rd street, Los Angeles. Bids on hydrants were rejected.

**BAKERSFIELD**—City engineer Greeley is preparing plans for paving 20 ft. wide on 15 blocks of Union avenue, being the unpaved portion of the state highway through the city. ——Contract for furnishing explosives for highway commission

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has been awarded to Hercules Powder Co., Chronicle Bdg., San Francisco, for $12,326.65.

**CALEXICO**—Improvement of several streets with Topeka specification pavement is being considered. I. R. Ralston, Box 444, is interested.

**CALIPATRIA**—J. F. O'Byrne has been awarded contract for erection of two-story brick and concrete building for First National Bank.

**CHOWCHILLA**—Contract for three-mile extension of Chowchilla Pacific railroad has been awarded to Chadwick & Sykes, Crocker Bdg., San Francisco.

**COLTON**—Contract for erection of brick building at Colton high school has been awarded to Nance & Phelps, 9th street and Central avenue, Los Angeles, for $50,340.

**COLUSA**—Bids will be received until April 6 by board of supervisors for construction of a number of concrete bridges. J. W. Kaerth is county surveyor.

**DOYLE**—Land-owners in this region have perfected temporary organization looking to the formation of irrigation district. R. M. Rankin, Susanville, and Elbert Howard are interested. An assessment of 10c. per acre for preliminary expenses has been levied.

**EAST SAN DIEGO**—Contract for paving on University avenue and on Steiner street has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, at 26c. per sq. ft. for asphalt paving, 50c. per cu. yd. for excavation, 14c. per sq. ft. for cement sidewalk, 30c. per lin. ft. for concrete curb, and 45c. per sq. ft. for granite block gutter, smaller items bringing the total price up to $97,184.72.——City clerk will receive bids until 7:30 p.m., April 5, for improving 6000 lin. ft. on Hugo avenue and cross streets, involving the following work: 36,400 cu. yd. excavation, 40,700 cu. yd. embankment, 4900 cu. yd. decomposed granite for paving, 13,200 lin. ft. curb, 68,000 sq. ft. sidewalk, 13,400 sq. ft. cobblestone gutters, also culverts and inlets. Engineer's estimate, $50,000. H. A. Kuehmstead, city engineer.

**EL CENTRO**—Volcano Lake levee in Imperial valley will be raised, involving about 350,000 cu. yd. embankment. Work is being done under supervision of C. R. Rockwood, chief engineer Imperial irrigation district.

**EL MONTE**—Contract for about 84,000 sq. ft. macadam pavement has been awarded to Bingham & Pendleton, 310 Summit avenue, Hermosa Beach.——Contract for constructing about 1300 lin. ft. cement curb has been awarded to J. M. Montgomery, Alhambra.

**EXETER**—Santa Fe railroad has secured rights-of-way for extension of road to Lindsay and Portersville, and construction will commence in spring.

**FAIRFIELD**—Board of Supervisors will receive bids until April 6 for construction of four bridges on state highway

**FONTANA**—William Curlett & Son, 518 Merchants Bank Bdg., Los Angeles, are preparing plans for reinforced concrete buildings to be erected by Fontana Land Company.

**FRESNO**—Bids will be received until 9 p.m., April 5, by W. H. Ryan, city clerk, for furnishing the following: One motor-driven hose-wagon and one motor-propelled fire-engine, with either motor-actuated or steam-actuated pumps, capacity 900 gal. per minute.——Board of Supervisors will receive bids until 2 p.m., April 14, for construction of buildings at hospital. Plans from Glass & Butner, Republican Bdg., upon deposit of $5.——Contracts for paving intersection of Kearney and Fresno avenues and for cement sidewalks on R street have been awarded to Thompson Brothers.——Resolutions of intention for about $100,000 worth of street work were passed. Most of this will be done by private contract. B. E. Cronkhite, city engineer.——R. L. Felchin has prepared plans for alterations to business buildings owned by H. H. Brix, costing $20,000.——Contract for improving part of Fresno street and Kearny avenue has been awarded to Thompson Bros.

**GRASS VALLEY**—Pacific Gas & Electric Co. has agreed to build a pipe-line 2200 ft. long to city reservoir.

**GRIDLEY**—City engineer Felleman is preparing plans for street paving.

**HANFORD**—City engineer Enderlein has reported that the cost of proposed street paving will be $185,000. Work includes paving on Douty, Redington, Harris, and Irwin streets from north city limits to a point about one mile south, also completion of 7th street paving, about five miles in all——Board of Supervisors has called election for May 6 to vote on bond issue of $672,500 for construction of county highway system.——Board of Supervisors will receive bids until April 7 for construction of bridge over Cross creek on state highway. Ben Duffield is county surveyor.

**HEALDSBURG**—Trustees have decided to pave several streets with 4-in. cement concrete base and 2-in. asphaltic concrete wearing surface.

**HOLLISTER**—Town trustees have decided to spend about $25,000 during summer on paving on Monterey and South streets.

**HUENEME**—J. Schulz, Wright & Callender Bdg., Los Angeles, is preparing plans for reinforced concrete wharf for Farmers' Warehouse Company.

**HUNTINGTON BEACH**—Contract for various street improvements has been awarded to Johnson-Shea Co., Riverside, at $72,762.——City council is receiving bids for construction of sewer system.

**HUNTINGTON PARK**—Bids will be received until 5 p.m., April 5, for construction of oil macadam pavement and culverts on Irvington avenue for approximately 2400 lin. ft.

**IONE**—Property owners in this vicinity are considering formation of irrigation district covering 20,000 acres. John V. Powers is interested.

**LODI**—City trustees will construct municipal swimming tank.

**LONG BEACH**—Contract for improving parts of Third street, Riverside drive, and other streets has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles.——Contract for cement curbs and sidewalks on Redondo avenue has been awarded to J. Driskill, 539 Coronado avenue, at 35c. per lin. ft. for curbs and 16c. per sq. ft. for sidewalks.——Contract for cement curbs and sidewalks on 15th street, Ohio avenue, and Newport avenue has been awarded to J. L. Frazier, 29 Orange avenue, at 31c. per lin. ft. for curbs and 11c. per sq. ft. for sidewalks——Contract for paving several alleys has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for 15c. per square foot.——Contract for construction of outfall sewer, involving about 1100 ft. of 36-in. cast iron pipe, has been awarded to Mercereau Bridge & Construction Co., Pacific Electric Bdg., Los Angeles, for $29,007.

**LOS ANGELES**—Contract for erection of brick depot building for Wells-Fargo & Co. Express has been awarded to Alpeter, Hall & Alpeter, 705 Ferguson Bdg., for $28,901.——Contract for erection of Los Feliz school has been awarded to Merchants' Realty & Investment Co., 304 Van Nuys Bdg., for $48,749.——Contract for improving Lucretia avenue has been awarded to Wattson & Spicer, Wright & Callender Bdg, at $4397.23.——Contract for improving Mohawk street has been awarded to California-Arizona Construction Co., Brockman Bdg., at $6715.13.——Contract for improving alley near 25th street has been awarded to California-Arizona Construction Co., for $1722.67, and for improving 15th street, to same company, for $4115.22.——Contract for improving Allesandro street has been awarded to E. J. Hein, 511 Stimson Bdg., at $5638.47.——Contract for improving 69th and 70th streets has been awarded to J. J. Papac, 726 North Hill street at $5009.56.——John Sutalo, 844 North Beaudry avenue, has been awarded following contracts for the following sewer work: On Gregory avenue for $400, on Gaffey street for $271, on 12th street for $1967, on Wall street for $614.——Contract for about 1,000,000 cu. yd. dredging in Los Angeles harbor has been awarded to S. G. Hindes, Nevada Bank Bdg., San Francisco, for $0.1046 per cu. yd.——Contract for furnishing 92,500 tons of rock for bulkhead has been awarded to Russell, Green & Foley, Higgins Bdg., for $1.13 per ton in place.——Contract for furnishing four direct-connected centrifugal pumping units for Monidoka project, Idaho, has been awarded to Smith-Booth-Usher Co, 228 Central avenue, for $896.——Contract for improvement of San Marino street has been awarded to California-Arizona Construction Co., Brockman Bdg., for $7728.22.——Contract for construction of church of hollow tile and concrete, costing about $20,000, has been awarded to H. S. Fredericksohn, 610 San Fernando road, Tropico.——City engineer has been directed to prepare plans for viaduct on 7th street over Santa Fe and Salt Lake railroad tracks and the river.——City has purchased 8000 water meters from Neptune Meter Co., 411½ East 3rd street.——Harbor commission has rejected all bids for roofing and has decided to make composition roof of its own. Harbor engineer has been instructed to draw up specifications for felt, asphalt, and gravel separately.——A. B. Benton, 114 North Spring street, is preparing plans for reinforced concrete apartment building for O. T. Johnson.——C. Karseboom, 1445 Dana street, has been awarded contract for erection of brick library building at Central avenue and 45th street for $25,469.——Contract for lighting posts and fixtures on Figueroa street has been awarded to Keystone Iron Works, 965 North Main street.——California Arizona Construction Co, Brockman Bdg., has been awarded contract for improvement on Kenmore avenue at $9391.87.——Norman F. Marsh is preparing plans of high school buildings at 38th and Hooper streets costing $200,000.——Board of Supervisors will receive bids until 2 p.m., April 5, for furnishing galvanized and corrugated iron for shop buildings.——Contract for street improvements in Los Feliz avenue district has been awarded to R. F. Wyckoff, 408 Consolidated Realty Bdg., for $65,708.64.

**LOS GATOS**—All bids for furnishing fire apparatus have been rejected, and town clerk will receive new bids until April 5.

**MANHATTAN BEACH**—Contract for improving 15th street

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and three other alleys has been awarded to Modern Construction Co., 1006 Wright & Callender Bdg., Los Angeles, for $14,251.20.

**MARIAN**—Bonds for $55,000 for construction of grammar school have been voted.

**MODESTO**—Bids will be received until April 10 by C. S. Abbott, secretary of Modesto irrigation district, for construction of Riarden and Slater hydraulic fills, involving about 170,000 cu. yd. embankment and 2500 cu. yd. reinforced concrete. F. C. Herrmann, Merchants Exchange Bdg., San Francisco, is engineer.——Chicago Bridge & Iron Works, Chicago, has been awarded contract for construction of 100,000-gal. water tank for city at $5350. W. H. Worswick, Jr., has been awarded contract for construction of cement foundations for $498.50.——Contract for paving three blocks on 7th street has been awarded to W. H. Worswick, Jr.

**OAKLAND**—Contract for improving Oak street from 7th to 14th streets has been awarded to Ransome-Crummey Co., First National Savings Bank Bdg.——Contract for improving part of 16th street has been awarded to Federal Construction Co., Sharon Bdg., San Francisco.——Contract for improving parts of Forest street and Miles avenue has been awarded to E. H. Sundberg, Oakland Bank of Savings Bdg.——Bates, Borland & Ayer, Crocker Bdg., San Francisco, has been awarded contract for street improvements on Persimmon street and on 82nd avenue, and for sewers on Walnut avenue, 55th avenue, and other streets.——Contract for repairing Bay Farm Island bridge has been awarded to Duncanson-Harrelson Co., Chronicle Bdg., San Francisco, for $5391.13.

**ONTARIO**—Joe Chutuk, 532 South Mathews street, Los Angeles, was awarded contract for construction of outfall sewer at $14,456. Work includes about 20,000 lin. ft. of 10-in. and 18-in. vitrified clay pipe.

**OROVILLE**—Contract for grading, curbs, and warrenite pavement on asphaltic concrete base on several streets has been awarded to Clark & Henery Construction Co., Sacramento, for $30,974.65.——Council has adopted resolutions of intention for twenty additional blocks of paving.

**PACOIMA**—Contract for construction of grammar school building has been awarded to Mann & Knox Construction Co., Delta Bdg., Los Angeles, for $11,529.

**PASADENA**—Contract for furnishing 4800 lin. ft. of 4-in. cast iron pipe has been awarded to United States Cast Iron Pipe Co. at $32.85 per ton.——Street superintendent will receive bids for construction of underground conduits for electric wires on Terrace drive and Elevado drive. Approximate quantities are 2500 ft. of 7-duct fibre conduit, consisting of seven 3-in. fibre tubes, with manholes and laterals.——Contract for construction of ornamental lighting posts on Bellefontaine street has been awarded to Southern California Electric Co., 625 South Main street, Los Angeles, for $3247.——Contract for furnishing 4500 lin. ft. of 24-in. riveted steel pipe and fittings has been awarded to Llewellyn Iron Works, Main and Redondo streets, Los Angeles, for $5319.

**PLACERVILLE**—City trustees will build reinforced concrete bridge over Hangtown creek costing $1000.——Trustees have ordered repairs and replacements on Main street sewer, and construction of sidewalks on several streets.——Owners of Marble Valley lime quarry are considering increasing capacity of plant. Fred Dixon is manager.

**QUINCY**—County clerk will receive bids until 10 a.m., May 3, for construction of bridge at Virgilia, also for construction of Sierra Valley sand road. Plans and specifications on file with county surveyor.

**RED BLUFF**—Paving of 14 blocks on Main street has been decided upon.——County surveyor W. F. Luning is preparing plans for 2000-ft. concrete bridge across 'sand slough.' Bond election will probably be held in July.

**REDDING**—Chico Construction Co., Chico, will pave five blocks with 4-in. concrete base and 2-in. asphalt wearing surface.

**REDONDO BEACH**—Bonds for $121,000 for construction of municipal pier have been voted.

**REDLANDS**—Contract for installing automatic lawn-sprinkling system at high school has been awarded to W. J. Miles.

**REDWOOD CITY**—Contract for construction of highway from Menlo Park to Portola has been awarded to Clark & Henery Construction Co., Sacramento, for $23,564.——Contract for construction of highway from Colma to Edgemar has been awarded to Colma Construction Co., Colma, for $44,133.——Board of supervisors will receive bids until April 5 for construction of 3-span reinforced concrete bridge. Plans on file with county surveyor.

**REEDLEY**—Specifications are being prepared for direct-connected gas-engine and pump for water department, to deliver 750 gal. per minute against head of 180 ft. Charles M. Knauer is city clerk.

**RICHMOND**—Contract for construction of municipal wharf has been awarded to Healy-Tibbetts Construction Co., Main and Market streets, San Francisco, for $212,344.

**RIVERBANK**—Citizens have voted in favor of installing lighting system.

**RIVERSIDE**—Contract for improvements on Banning and Warm Springs road has been awarded to B. R. Davisson Construction Co., Monrovia, for $63,954.64.

**ROSEVILLE**—Contract for theatre has been awarded to C. H. Hansen, Lincoln.

**SACRAMENTO**—Shea & Lofquist, 742 Market street, San Francisco, will prepare plans for Hall of Justice, costing about $200,000.——McGillivray Construction Co., 634 Townsend street, San Francisco, has been awarded contract for paving six blocks on E street.——Bids for paving on D street have been rejected because too high, and bids will be readvertised, calling for macadam on concrete base.——Bids will be received until 2 p.m., April 5, by State Highway Commission, Forum Bdg., for construction of the following parts of the state highway: Grading and culverts on 4 miles in Orange county near Sierra. Concrete pavement in Tulare county, between Goshen and Traver, 8½ miles, and between Traver and the northern boundary of county, 5 miles. Concrete pavement in Yolo county between Yolo by-pass and Sacramento river, 3½ miles. Grading and some concrete pavement between Davis and Yolo by-pass, 5 miles. Concrete pavement in Yuba county between Morrison's crossing and southern county boundary, 3 miles.——Bids will be received until 11:30 a.m., April 20, by M. J. Desmond, city clerk, for construction of water system. Work includes 126,000 cu. yd. excavation, 126,000 cu. yd. backfill, 417,920 lin. ft. cast iron pipe, from 4 to 16 in. diameter, 39,990 lin. ft. riveted steel pipe, 20, 24, 30, and 36 in. diameter, 758 hydrants, 1472 valves 4 to 30 in., 220 tons cast iron special fittings, 22,084 sq. yd. pavement to be removed and replaced.——City engineer Miller has reported on two plans for Bryte's Bend by-pass and weir. One will cost $438,000, of which city will pay $219,500 and state reclamation board the remainder. The other uses a more expensive weir gate at $678,000.——E. J. Carragher, president of playground board, is receiving bids for construction of concrete bathing pool at McKinley park.——Contract for improvement of 11 blocks on V street has been awarded to Clark & Henery Construction Co.——Six-story office building, costing $250,000, will be erected at 10th and K streets. W. E. Briggs is interested.——Contract for installation of 13 electroliers on Maple avenue has been awarded to Scott, Lyman & Stack.——Contract for grading and concrete sidewalks on 30th street, from B to R, has been awarded to Hughes Construction Company.

**SALINAS**—Recount of votes on recent road bond issue shows that bonds received the necessary majority, and removes all obstacles to their being issued.

**SAN BERNARDINO**—Bids will be received until April 12, by F. W. Conrad, secretary of board of education, for furnishing 3 engine lathes, one 'Universal' milling machine, one 30-in. radial drill press, one 24 by 6-in. planer, one 30-in. single wood planer, one 'Universal' saw table, one exhaust fan, one 36-in. band saw, one oilstone grinder, one double arbor emery wheel.

**SAN DIEGO**—City council has authorized superintendent Manney to construct beacon in harbor costing $3000.——Contract for concrete foundations for three 600-ft. steel wireless towers has been awarded to Isbell Construction Co. for $7215.

**SAN FRANCISCO**—Contract for construction of sidewalks at the Civic Center has been awarded to J. G. Harney, 3619 18th street, for 10.3c. per sq. ft. Contract for paving part of 22nd street has been awarded to City Street Improvement Co., 166 Geary street, for $4407.——Board of Works has ordered the following street improvements: Paving on part of Cumber street, cost about $6600; grading and construction of sewers on Madrid street; curbs, sidewalks, and asphalt pavement on part of Liebig street; curbs, catch-basins, culverts, and asphalt pavement on Arguello boulevard; asphalt pavement on part of Virgil alley; curbs and asphalt pavement on part of Utah street, and part of San Bruno avenue; sidewalks on part of Greenwich street; curbs, sewers, catch-basins, culverts, and asphalt pavement on part of Taylor street, and part of Willard street; curbs and asphalt pavement on part of Judah street; curbs, sidewalks, and asphalt pavement on part of Lincoln way.——Contract for excavation and foundations for public library at Civic Center has been awarded to Contra Costa Construction Co., 330 10th street, for $28,300.——Contracts for construction of branch library have been awarded as follows: General contract to C. H. Holt for $25,240. Structural steel to Western Iron Works, 141 Beale street, for $3460. Terra cotta to Gladding, McBean & Co., Crocker Bdg., for $9200.——Marcus Loew will erect theatre, costing $400,000, on Market street near 4th street. H. Ryan, Northern Bank Bdg., Seattle, is architect.——H. G. Vaughn, Foxcroft Bdg., and Blanchard-Brown Co., 660 Market street, were low bidders for paving Portola drive at 15.4c. per square

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foot each.——Board of Works has ordered following street work: Grading and construction of sewers on Bemis street; asphalt pavement, culverts, catch-basins, sidewalks, and curbs on part of Stillman street; curbs and brick and asphalt pavement on Corbett avenue; sewer on part of Silver avenue; curbs, culverts, catch-basins, and asphalt pavement on Ocean avenue; curbs and asphalt pavement on London street; sidewalks on a number of streets.——Board of Works has ordered the following street improvements: Part of Fairfax avenue, cost $22,250. Grading part of Quesada avenue, cost $7500. Building sewer and paving on part of Moraga avenue, cost $4100.——Bids will be received until 2 p.m., April 6, by the Lighthouse Inspector, 18th district, for delivery at waterfront of two iron mammoth whistling buoys, in accordance with lighthouse specifications for buoys and blueprint of lighthouse mammoth whistling buoy.

**SAN JOSE**—J. W. McDonald Co. has been authorized to pave one block on 9th street by private contract for 16½c. per sq. ft., including grading.——City council has adopted plans and specifications for paving several streets. R. E. Walter is city clerk.——City engineer Maggini has been instructed to prepare plans for resurfacing and reguttering several streets in business district, also for culvert on Orchard street.——Improvement of thirteen blocks on William street under Vrooman act by 4½-in. concrete base and 1½-in. asphaltic concrete wearing surface, concrete curbs and gutters, and brick catch-basins has been ordered.

**SANTA ANA**—Board of supervisors has decided to use unexpended balance of $240,000 from highway bond issue to build about 35 miles of roads in various parts of the county. ——Directors of Newbert protection district have decided to install pump and engine. H. Clay Kellogg is engineer.——Contract for construction of about 2¼ miles of Anaheim-Olive road has been awarded to Hart & Ducey, 507 East Orange Grove avenue, Pasadena, for $7550.54.

**SANTA BARBARA**—Contract for paving on Garden and Los Olivos streets has been awarded to F. R. Ritchie Co., Chronicle Bdg., San Francisco, for $24,208.95.—A. A. Lemmon has been awarded contract for construction of part of Sola street sewer. ——Contract for construction of Sola street sewer has been awarded to A. L. Pendola and E. A. Garland for $10,440.——Sewer 356 ft. long will be laid on Islay street.

**SANTA CLARA**—Paving, cement gutters, curbs, and sidewalks have been ordered on several streets.

**SANTA CRUZ**—Council will receive bids for sewers on Plateau, Almar, and Knower avenues.——Contract for transformers at municipal wharf has been awarded to General Electric Co. for $525.

**SANTA ROSA**—City engineer is preparing plans for improvement of part of Brown street.

**SEBASTOPOL**—Contract for erection of concrete warehouse for Berry Growers' Association has been awarded to Bailey-Comstock Co., Santa Rosa, for $12,000. Contract for foundation has been awarded to D. E. Albers, Santa Rosa.

**SIERRA MADRE**—Contract for erection of buildings at grammar school has been awarded to Tasker M. Webster, at $10,108.90.

**SPRINGVILLE**—San Joaquin Light & Power Co. is considering construction of 9-mile canal, including two miles of tunnels. A. G. Wishon, Fresno, is general manager.

**STOCKTON**—Irey & McCleary, Lodi, have been awarded contracts for road work as follows: Graveling and grading Upper Sacramento road at $25,042.49. Constructing culverts on Stockton-Mokelumne Hill road, at $7 each. Constructing bridges and culverts on Sacramento road at $10,001.29.——Following bids were received for throwing up embankment on Bordon road: Union Dredging Co., $85 per day; San Joaquin Dredging Co., $70 per day.——City council has called for bids for storm sewers in district lying east of Yosemite terrace. Estimated cost $5291. Specifications have been adopted for sanitary sewers in Fair Oaks district; estimated cost, $9344.——R. W. Moller, 180 Jessie street, San Francisco, was awarded contract for erection of El Dorado school at $60,534 for a 12-room building and $65,934 for a 14-room building. ——City council has adopted resolutions of intention for sewers in Fair Oaks district.——Contract for street work in southwestern part of city has been awarded to F. C. McIntire for $31,101.36.——City council has ordered installation of a number of street lights.——Contract for construction of St. Gertrude's church has been awarded to James Mulcahy for $25,187.

**TERRA BELLA**—Stephen E. Kieffer, Berkeley, has reported that an irrigation system covering 13,500 acres in this vicinity can be constructed for $839,000.

**TROPICO**—Contract for improving Cypress avenue has been awarded to E. A. McCombs and J. S. Burk for about $8000.

**TURLOCK**—City clerk is receiving bids for sewer work on West Main street.

**VISALIA**—Bids will be received until 11 a.m., April 7, by board of supervisors for construction of bridge across Cameron creek in Mooney grove. Plans on file with county surveyor.

**WATSONVILLE**—Monterey county supervisors and city council have adopted plans prepared by Leonard & Day, Rialto Bdg., San Francisco, for reinforced concrete bridge over Pajaro river costing $35,000.

**WINTERS**—City trustees will erect 100,000-gal. steel water tank and tower.

**WOODLAND**—E. L. Younger has been awarded contract for construction of theatre.

**YREKA**—Board of supervisors will receive bids until 10 a.m., April 5, for widening part of Dorris and Oklahoma road. ——County surveyor has prepared plans for four bridges on state highway.

### DISTRICT OF COLUMBIA

**WASHINGTON**—Bureau of Supplies and Accounts, Navy Department, will receive bids until April 6, for the following: For delivery at Mare Island, California, one cutting device for oxy-acetylene plant, schedule 8018; two 25-kw. turbo-generators, schedule 8020; one vertical simplex pump, schedule 8019; miscellaneous quantity wrought pipe, schedule 8045; miscellaneous quantity rubber fire hose, schedule 8016; 1500 ft. rubber wire wound steam hose, schedule 8017. Also until April 13, for delivery at Puget Sound, Washington, 4032 sq. ft. hot water radiators.——Bids will also be received until April 6, for delivery at Mare Island, California, for two evaporators, schedule 7959, two lubricating oil pumps, two main air pumps, two main feed pumps, schedule 7960.——Bureau of Supplies and Accounts, Navy Department, will receive bids until April 13 for the following: For delivery at Mare Island, California, miscellaneous quantity steel nuts and wrought iron screw shackles, schedule 8077; miscellaneous quantity electrical resistance wire, globe and reflectors, and 100 shade holders, schedule 8067. For delivery at Puget Sound, Washington, miscellaneous quantity seamless drawn brass pipe, schedule 8078. Also until April 20, 20,540 lb. steel forgings for delivery at Mare Island, California, schedule 8066, and one electric driven derrick hoist for delivery at Puget Sound, Washington, schedule 8065. Particulars from the Purchasing Pay Officer, U. S. Navy Pay Office, San Francisco, California.——Bureau of Supplies and Accounts, Navy Department, will receive bids until April 20, for the following: For delivery at Puget Sound, Washington, 400 ft. 1¼-in. rubber hose, schedule 8097; for delivery at Mare Island, California, 1900 lb. 1¼-in. and 3-in. brass pipe, 2500 ft. 1½-in. wrought pipe, schedule 8095; 5000 iron or steel buckets, schedule 8096; 3000 lb. ⅞-in. steel nuts, 10,000 lb. plate zinc, schedule 8095; 3000 lb. sheet copper, schedule 8097; 2500 lb. corrugated sheet steel; 24,000 lb. galvanized sheet steel, schedule 8094.——Also until April 27, for delivery at Mare Island, California, miscellaneous quantity of awls, bits, pliers, saws, machinists' hammers, and handles, books, turn buttons, cotter springs, pipe wrenches, screw wrenches, machinists' bench vises, schedule 8087; for delivery at Puget Sound, Washington, miscellaneous quantity hacksaw blades, bronze chest hasps, schedule 8087; for delivery at East and West points, miscellaneous quantity fuel oil, schedule 8083.

### IDAHO

**ASHTON**—Contract for construction of 600-ft. tunnel on Oregon Short Line has been awarded to Utah Construction Co., Ogden, Utah.

**BOISE**—Council is considering installation of lighting system on South Side costing $5000. C. C. Stevenson is city engineer.

**LEWISTON**—Warren Construction Co., Journal building, Portland, Oregon, has been awarded contract for highway improvements in Lewiston Orchards, costing $100,000.——Contract for grading, draining, and wood and concrete bridges on highway has been sublet to C. M. Payne, 724 Mission street, Spokane, Washington.——Idaho Asbetos Co. will erect plant. J. E. Snyder is president.

**POCATELLO**—Sollie, Boyer & Rogers have prepared plans for six-story hotel costing $300,000.

**SANDPOINT**—City council is considering expenditure of $75,000 to $100,000 on street improvements.

**ST. MARIES**—Contract for bridge at St. Mary river crossing has been awarded to Minneapolis Bridge Co., Minneapolis, Minnesota, for $8823.77.

**VIEW** (Burley P. O.)—View Development Co. will construct water system. J. C. Burgess and J. D. Hoagland are interested.

**WEISER**—Contract for construction of irrigation system for east of Weiser district has been awarded to H. B. Wright for $11,011.40.

### MONTANA

**BOZEMAN**—Contract for erection of steel bridges has been awarded to Minneapolis Bridge Co., Minneapolis, for $2665.

**BUTTE**—Arizona street storm sewer will be rebuilt from Platinum street to Second Street playgrounds. Cost about $25,000.

**CLYDE PARK**—Charles T. Sacket, Livingston, is preparing plans for municipal water system costing $18,000.

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**COLUMBUS**—Bids will be received until 10 a.m., April 12, by L. B. Barley, county clerk, for construction of five bridges, spans from 22 to 95 ft. Particulars from R. W. Barr, county surveyor.

**GREAT FALLS**—Contract for construction of Y. M. C. A. building has been awarded to Lange Construction Co. for $73,550.——Leighland & Kleppe have been awarded contract for construction of New Park hotel at about $150,000. Building will be reinforced concrete, brick, and terra cotta.——Contract for construction of concrete walks and curbs has been awarded to Fred Saner, Butte, for $5199.

**HAVRE**—Bids will be received until April 10 by county clerk for construction of court-house. Frank Bossout is architect.

**MILES CITY**—Lowest bid for construction of public building was submitted by Hiram Lloyd Building & Construction Co., St. Louis, for $92,517.

**PHILLIPSBURG**—Town council is considering improvements and additions to water system. O. H. Green & Co., Paulsen building, Spokane, Washington, are engineers.

**RADERSBURG**—Keating Gold Mining Co. will construct railroad to Toston.

### NEVADA

**FALLON**—Bonds for $50,000 for road improvements have been voted.

**LAS VEGAS**—Campbell & Turner have been awarded contract for constructing steel bridge over Virgin river near St. Thomas, at $9210.

**RENO**—City council is considering construction of steel or concrete bridge over Truckee river. Estimated cost $12,000. J. R. Meskimons, city engineer.——Plans are being considered for draining about 8000 acres of swamp land in this vicinity. Estimated cost $20,000. Dr. J. L. Robinson is interested.——Contract for construction of booths at Panama-Pacific Exposition has been awarded to C. G. Sellman for $15,800.——Steamboat Springs Mining & Development Co. has applied for franchise for hot-water piping system.

### OREGON

**ASHLAND**—Contract for auxiliary water system has been awarded to Smith, Emery & Co., 651 Howard street, San Francisco, for about $100,000.

**BAKER**—W. L. Boyes has been awarded contract for erection of school building for district No. 81.

**BAY CITY**—Contract for grading, macadamizing, and construction of concrete and wood curbs on various streets has been awarded to P. A. Sandberg, 408 Stanton avenue, Portland, for $33,363.

**FAIRVIEW**—Council is considering construction of municipal water system.

**FLORENCE**—Bonds for $100,000 for port improvements at the mouth of Siuslaw river have been sold, and bids will soon be called for. I. B. Cushman is chairman of Siuslaw Port Commission.

**GOLD HILL**—City recorder will receive bids until April 7 for installation of street-lighting system and furnishing electric current for 10 years.

**GRESHAM**—Contract for construction of high school building has been awarded to J. H. Tillman & Co., Chamber of Commerce Bdg., Portland, for $17,990.

**KLAMATH FALLS**—Following contracts have been awarded for excavation on Griffith lateral by project manager J. G. Camp: Schedule 38, involving 45,000 cu. yd. first-class and some second-class material, at 17½c. and 30c. Schedules 6 to 10, to J. A. Maddox at 18c. for first class and 30c. for second class. Schedules 36 to 42, to J. A. Maddox at above prices or to W. H. Mason for 19½c. and 30c.

**MILWAUKEE**—Temporary injunction restraining the city from entering into a contract for construction of water system has been dissolved, and contract has been awarded to Giebisch & Joplin, Rothchild Bdg., Portland, at $16,400.

**OREGON CITY**—City engineer has been instructed to prepare specifications calling for asphaltic concrete for paving Main street.

**PORTLAND**—Following contracts have been awarded for construction of Interstate bridge: Manufacturing main bridge span, American Bridge Co., $417,316.20; manufacturing Oregon Slough span, Northwest Steel Co., 420 North Front street, $89,140.50; erecting main river span, Porter Bros., Railway Exchange Bdg., $99,829; erecting Oregon Slough span, Porter Bros., $18,586.50; erecting main river substructure, Pacific Bridge Co., Water & Salmon street, $319,415; erecting Oregon Slough substructure, Pacific Bridge Co., $119,759; embankment, Tacoma Dredging Co., National Bank of Tacoma Bdg., Tacoma, $158,214.40; laying floors, Warren Construction Co., Journal Bdg., $82,802.93.——Contract for construction of concrete and asphalt tennis courts at Reed college has been awarded to Oskar Huber, Electric Bdg., for $5653.80——Contract for furnishing 436 meters has been awarded to Neptune Meter Co. for $4152.——Following bids have been received for pavement in Grand Avenue district: Warren Construction Co., Journal Bdg., asphalt, $1.48 per sq. yd.; gravel bitulithic, $1.45; bitulithic, $1.85. Oregon Hassam Paving Co., Board of Trade Bdg., class A hassam, $1.49; class B, $1.25. Bids were also received for Washington street paving as follows: Warren Construction Co., asphalt, $1.07 per sq. yd.; bitulithic, $1.41. Oskar Huber, Electric Bdg., asphalt, $1.05; bitulithic, $1.15. Oregon Hassam Pavement Co., asphalt, $0.80.——Contract for construction of two reinforced concrete bridges on Columbia highway has been awarded to Robert Wakefield, Worcester Bdg., for $16,904 and $3979, respectively. Contract for a third bridge has been awarded to A. Guthrie & Co. for $14,363.70.——Contract for furnishing 4250 tons of cast iron pipe to city has been awarded to United States Cast Iron Pipe & Foundry Co., Northwestern Bank Bdg., for $29.48 per ton. A portion of this work will be sublet to Oswego Iron Works. Contract for furnishing 50 tons of fittings has been awarded to Smith & Watson Iron Works, Front and Harrison streets, for 2¾c. per pound.——Contract for furnishing two boilers for dredge 'Columbia' has been awarded to Ballin Watertube Boiler Co., Worcester Bdg., for $26,875. Contract for circulating pump has been awarded to Platt Iron Works, Dayton, Ohio, for $900.——Brayton Engineering Co., Pittock Bdg., has been awarded contract for erection of open dock adjoining municipal dock No. 1, at $17,575.——Following street work has been ordered: Grading and cement sidewalks on Madrona street, costing $2666; on East 30th street, costing $1445; and on Yukon avenue, costing $2189. Also an improvement district in the vicinity of East 38th street, improvement consisting of grading and cement sidewalks costing $6454.——Contract for construction of Mitchell Point section of Columbia highway has been awarded to Standifer-Clarkson Co., Northwest Bank Bdg., for $40,343.50. H. L. Bowlby is state engineer.——Contract for erection of Interstate bridge which was awarded to Porter Bros. will be handled by McCreary & Willard, Seattle, Washington.——Contract for construction of stern-wheel steamer 'Woodland' for Corps of Engineers has been awarded to Joseph Supple, Belmont street, for $16,978.——R. E. Kremers, chief of bureau of highways and bridges, has recommended establishment of a municipal paving-repair plant costing about $10,000.——Warren Construction Co., Journal Bdg., has been awarded contract for paving on Grand avenue for $23,000.

**SILVERTON**—Contract for two-story high school building has been awarded to Anderson & Larson for $13,327.

**STAYTON**—Plans are being considered for electric railroad from East Stayton to Salem. E. O. Stafter is interested.

### UTAH

**CORINNE**—City will install electric lighting system. John Y. Ferry is mayor.

**DRAPER**—Draper Irrigation Co. will construct water system to supply eight small towns in this vicinity.

**HUNTINGTON**—Huntington Light, Power & Telephone Co. has been organized and will construct power plant and telephone system. Mart Jensen is president.

**MARYSVALE**—J. Ogden Armour, Chicago, will spend about $3,000,000 in development of potash deposits in this vicinity.

**OGDEN**—Mountain States Telephone & Telegraph Co. will expend $100,000 on underground conduits and other improvements during coming year.——Contract for furnishing 18,400 lin. ft. of 24-in. Matheson joint pipe has been awarded to Geo. A. Lowe Co. for $52,320.40.——Bids will be received until 10 a.m., April 13, by city commissioners for following work in connection with laying of pipe-line: 28,700 lin. ft. of trench, and hauling, laying, and calking of pipe. Plans on file with city engineer——Federal Land & Mortgage Co. will erect apartment house costing $300,000. Henry H. Meyers, Kohl building, San Francisco, is architect.

**PROVO**—Bids will be received until 2 p.m., April 8, at office of U. S. Reclamation Service, for construction involving about 8000 cu. yd canal excavation and 1350 cu. yd. reinforced concrete. The work is situated near Payson City, on the San Pedro, Los Angeles & Salt Lake railroad, and the Tintic branch of the Denver & Rio Grande railroad. Particulars from U. S. Reclamation Service, Washington, D. C., or Provo.—Wasatch Grading Co., Salt Lake City, was low bidder for construction of lateral canal, 8½ miles long, at $47,083.62.

**SALT LAKE CITY**—L. A. Martin and associates are promising a five-mile tunnel to drain mines in Tintic district.—W. B. Black has been awarded contract for erection of grand-stand, bleachers, and other buildings at ball park.——Millard County Richlands Irrigation Co. will install tile drainage system. Geo. T. O'Dell is president. Work will be done under direction of state engineer.——Street commissioner Morris has recommended expenditure of $75,000 for street paving.

### WASHINGTON

**ABERDEEN**—Council has rejected all bids for furnishing new pump, and bids will be readvertised. Estimated cost $5000.

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**ANACORTES**—Bond issue of $130,000 for purchase and improvement of water system has been defeated.——Contract for lateral sewer has been awarded to Nels Erickson for $2141.96.

**BELLINGHAM**—Weymouth Construction Co., Pier 1, Seattle, has been awarded contract for construction of 320-ft. steel bridge at $30,713.——Contract for construction of highway No. 2A has been awarded to Booker & Campbell, for $11,400.——County commissioners have decided in favor of hard surfacing 5 miles of Guide Meridian road and graveling 1½ miles of another road.——Contract for graveling 2 miles of northeast diagonal road has been awarded to A. E. Rusco for 98c. per yard. ——City water department is in market for 5000 ft. of 12-in. wood pipe, 7000 ft. of 8-in. iron pipe, 3000 ft. of 4-in. iron pipe, and 2500 ft. of 6-in. iron pipe.

**BENTON CITY**—Contract for construction of wood-stave pipe for Snipes Mountain pumping plant for Sunnyside unit, Yakima project, has been awarded to Pacific Pipe & Tank Co., Portland, Oregon, for $11,094.

**BUCKLEY**—Contract for paving on River avenue has been awarded to D. A. Trolson.

**CATHLAMET**—Bonds for $9500 for school building have been voted.

**CLARKSTON**—Contract for improvement of Bridge street and for construction of concrete sidewalk on approach to interstate bridge has been awarded to Robert Meyer.

**COUPEVILLE**—Contract for state road at Langley has been awarded to E. Howard for $2665.

**DAVENPORT**—Contract for gravel surfacing on road to Reardon, 12½ miles, has been awarded to Jacobsen-Bade Co., 407 Stanton street, Portland, Oregon, for $42,534.——Bonds for $40,000 for school building have been voted. H. L. Paige is clerk of board.

**ELLENSBURG**—Bids will be received until 7:30 p.m., April 5, by R. Crimp, city clerk, for construction of concrete power plant building, furnishing 1000-kw. steam turbine, one 325-hp. boiler, water wheel governor, and other equipment. Plans on file with city engineer.

**EPHRATA**—County commissioners will receive bids until 2 p.m., April 5, for construction of about two miles of permanent highway, from highway No. 5 to No. 734. Plans from county engineer upon deposit of $2. C. T. Sanders is county clerk.——Bids will probably be opened about May 3 by county commissioners for construction of seven miles of permanent highway. Cost about $36,000. E. H. Strading, county engineer.

**EVERETT**—County commissioners will receive bids until April 5 for construction of pile trestle approach to bridge 10 over Pilchuck river, also until April 12 for construction of concrete culvert and fill or steel viaduct on Pacific highway near Marysville.——County commissioners will receive bids until April 5 for grading 4200 ft. of road between Snoqualmie river and Cathcart. Also for construction of 8700 ft. of permanent highway No. 12. Hans Mumm, Jr., is county engineer.

**FERNDALE**—Contract for construction of post-office has been awarded to Scarlet & Jensen, Bellingham, for $2134.

**HOQUIAM**—Repairs costing $8000 on Eighth Street bridge have been ordered by council. Plans have been prepared by Charles Evan Fowler, Central building, Seattle.

**KALAMA**—Contract for street improvements has been awarded to Nicholson & Carson, for $3262.50.

**KENNEWICK**—Port of Kennewick has been created at election. W. R. Weisel, M. H. Church, and G. M. Annis are directors.

**MONTESANO**—Contract for construction of East Hoquiam road has been awarded to George Bowland for $8275. Contract for Ocosta-Bay City road has been awarded to Aug. Wallin for $1584.——Contract for equipment of power-plant for Northwest Electric & Water Works has been awarded to Lamb Machine Co., Hoquiam.

**MT. VERNON**—Contract for construction of steel bridge at La Conner has been awarded to Illinois Steel Bridge Co. for $20,000.

**NORTH YAKIMA**—Contract for construction of water bound macadam road to Wiley City has been awarded to Cascade Construction Co. for $2649.30.——Contract for construction of 22 miles of open drain ditches has been awarded to Carlson-Chindahl Co., Fernwell building, Spokane, for $70,940.77 cash or $74,067.96 in bonds. Contract for 6 miles of closed drains has been awarded to Mitchell Bros., 127 East Mission street, Spokane, for $20,013.94 cash or $20,915.26 in bonds.——County commissioners will receive bids until 2:30 p.m., April 5, for grading and graveling 4 miles of permanent highway No. 14. Plans from O. E. Brashears, county engineer, upon deposit of $5.——Contract for paving on South First street has been awarded to the Cascade Construction Co., Mutual Life building, Seattle, for $8498.——County commissioners will soon ask for bids for construction of drain ditches in district No. 25. Estimated cost $37,348.33.—Contract for remodeling Pioneer building has been awarded to Nettleton-Bruce-Eschbach Co., American Bank building, Seattle, for $12,200.——Expenditure of $987,975 on reclamation projects in Washington division has been authorized by Department of Interior.——About $10,000 will be expended on ditches in drainage district No. 24. M. Chandler and A. M. Dutcher will have charge of work.

**OLYMPIA**—State legislature has appropriated $2,152,288 and re-appropriated $153,640 for the construction and maintenance of state highways, and $4,000,000 for construction and maintenance of other permanent highways. These amounts will be expended during the biennium beginning April 1. In addition there will be expended about $4,000,000 for county funds for roads and bridges. The above does not include any expenditures that may be made within the limits of incorporated cities and towns.——Contract for construction of building for Olympia National Bank has been awarded to Hurley-Mason Co., Perkins building, for about $40,000.——City council has decided to build new drawbridge costing about $15,000 to connect East and West Olympia.——Contract for erection of temporary bridge across channel has been awarded to J. C. Perceval for $1246.47.

**PORT ORCHARD**—County commissioners will receive bids until April 6 for construction of bridge across lagoon at South Colby, and bridge near Silverdale.

**RAYMOND**—Bonds have been voted for the purchase of the local water system and for the expenditure of $22,500 on extensions to the system.

**RIDGEFIELD**—Contract for construction of transmission line to furnish energy for city has been awarded to NePage, McKenny & Co., Armour building, Seattle.

**RITZVILLE**—Contract for graveling part of Second street has been awarded to A. H. Zane & Co., for $492.——County commissioners will open bids early in April for construction of permanent highway from northern end of Washtucna highway toward Ritzville, about 7 miles. Cost about $25,000.——Contract for grading, culverts, and crosswalks on 2½ miles of streets has been awarded to A. H. Zane & Co., Hanford, for $7283.26.

**SEATTLE**—Contract for erection of steel for office building for Washington Securities Co. has been awarded to J. McArdle, 217 Cedar St.——Contract for ornamental iron for King County courthouse has been awarded to American Iron & Wire Works, 2921 First street.——Contract for removal of slides on Milwaukee line near Hoquiam has been sublet to McDonald & Jones, Globe block.——Contract for erection of Renton bridge has been awarded to Pacific Iron Works, Burnside bridge, Portland, Oregon, for $9744.35.——Bids will be received until March 12 by board of public works for construction of sewers on Lakeside avenue, water mains on 38th avenue, sewer on 38th avenue, and paving on Ewing and other streets.——All bids for construction of storage warehouse were rejected by port commission, and new specifications will be prepared.——Contract for construction of new cofferdams and removal of existing structures in Lake Washington canal at the Narrows has been awarded to Erickson Construction Co., Downs block, for $56,776. Work involves 181,000 cu. yd. dredging, and the removal and driving of round piles and sheet piling.——Contract for paving East 38th street and other streets has been awarded to Oregon Independent Paving Co., East Water and Salmon streets, Portland, Oregon, for $6454.——All bids for furnishing cement were rejected by port commission and chief engineer was authorized to make purchases in small quantities.——Contract for construction of sewers on Lakeside avenue has been awarded to T. Scalzo, 1708 22nd avenue, at $23,959.35.——Contract for grading and other work on 32nd avenue and other streets has been awarded to B. H. Petley, 1419 37th avenue, for $12,293.50.——Contract for water mains on 38th avenue has been awarded to N. Fiorito, 616 26th avenue, for $16,026.——Contract for erection of bridge over Tokul creek has been awarded to G. A. Marsh, Provident building, Tacoma, for $2314.——Bebb & Gould, Denny building, are preparing plans for five-story reinforced concrete building costing $85,000 for Fischer Building Co.——Bonds for the following bridges were voted at the municipal election: 15th avenue across Salmon bay, $479,000; Fremont avenue, $340,000; Eastlake avenue, $545,000.

**SEDRO WOOLLEY**—Contract for erection of reinforced concrete library building has been awarded to D. Dalton for $50,000. Chas. Saunders, 32nd avenue and 58th street, Seattle, is architect.

**SHELTON**—County commissioners will receive bids in April for construction of two bridges on Pump Creek road.

**SOUTH BEND**—Bids will be received until 11 a.m., April 6, by county auditor, for construction of 2½ miles of permanent highway No. 1A near Willapa station on Northern Pacific railway, including grading, ditching, building two small concrete bridges, several concrete culverts, and finishing with water-bound macadam surface, also such other improvements on an additional 1½ miles of highway as the county commissioners may authorize. Plans and specifications from Charles B. Nims, county engineer, upon deposit of $5.

**SPOKANE**—Commissioner McBroom will receive bids for sewer work on Northern Pacific grade changes costing about $50,000.

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## Personal

T. B. CHAMBERS has been reappointed street commissioner of Hood River, Oregon.

H. D. WILLIAMS, mining engineer, has opened offices at 332 Pittock building, Portland.

PAUL E. KRESSLY, city manager and city engineer of Inglewood, California, has resigned.

JOSEPH P. COTTON, of New York, has been appointed counsel for the Alaskan engineering commission.

JAMES B. TRUE has been appointed state engineer of Wyoming for the six-year term beginning February 20, 1915.

H. C. HARTUNG has been appointed general manager for the Lewiston-Clarkston Transit Co., with headquarters at Lewiston, Idaho.

Major JAMES B. CAVANAUGH, since 1911 in charge of construction of the Lake Washington Canal, Seattle, has been promoted to the rank of lieutenant-colonel.

FRANKLIN L. DAVIS, engineer and contractor, has opened offices at 514 Henry building, Portland, specializing in bridge and highway construction and public work in general.

HENRY A. CAMPBELL, consulting engineer for the San Francisco Chamber of Commerce, has opened offices as consulting engineer in the Merchants Exchange building, San Francisco.

W. H. HAZLETT, for 15 years with the British Columbia Electric Railway Co., has joined the firm of A. G. Langley & Co., Ltd., engineers and contractors, Vancouver, British Columbia.

M. L. KLINESMITH, for several years chief engineer for the producing department of the Kern Trading & Oil Co., has resigned in order to go to China in a similar capacity for the Standard Oil Company.

FRANK S. DRAKE, superintendent of the Yakima Valley Transportation Co., with headquarters at North Yakima, Washington, has resigned to enter business in Los Angeles, representing certain houses handling brick, tile, and electric railway specialties.

EMERY OLIVER, for several years engineer for Reclamation District No. 1001, along the Bear river, California, has resigned on account of pressure of other work. E. M. MACKUSICK, who has been Mr. Oliver's assistant for some time, was appointed his successor.

HIRAM N. SAVAGE, supervising engineer for the northern division of the United States Reclamation Service, has resigned to engage in private practice at Billings, Montana. CHARLES P. WILLIAMS, of Great Falls, Montana, has been appointed to succeed Mr. Savage.

Governor JOHNSON has made the following appointments to the California State Water Commission, established by the Legislature of 1913: IRVING MARTIN, editor of *The Stockton Record*; A. E. CHANDLER, irrigation engineer, of Berkeley; and former assemblyman W. A. JOHNSTONE of San Dimas.

F. C. HERRMANN, consulting engineer, San Francisco, has been appointed chief engineer of the Modesto irrigation district, California. He has appointed as his assistants O. W. PETERSON, who will have charge of construction in the district, and P. M. JONES, who will supervise the water measurements now being taken of the Tuolumne river for use in the suit of the district against the city of San Francisco. H. T. CORY and W. K. WINTERHALTER have been employed as consulting engineers and also as expert witnesses in the suit against the city.

At the meeting of the Inland Waterways Association of California held in San Francisco, March 23, 24, and 25, the following officers were elected for the ensuing year: president, ISIDOR JACOBS, of San Francisco; first vice-president, M. E. DITTMAR, of Redding; second vice-president, WILLIS BOOTH, of Los Angeles; third vice-president, Mrs. E. G. GREENE, of Palo Alto; fourth vice-president, JOHN FAIRWEATHER, of Fresno; treasurer, J. L. CRAIG, of Stockton; secretary, CRAGIE SHARP, of Oakland. DAVID H. WALKER, of San Francisco, was reelected executive secretary. Besides several non-technical addresses by VICE-PRESIDENT MARSHALL and others, the following addresses of engineering interest were delivered: 'Water Resources of California as a Basis for Reclamation Projects,' by E. G. HOPSON, engineer, United States Reclamation Service, Portland; 'Co-ordination of Water Utilization Problems,' by M. E. DITTMAR, mining engineer, Redding; 'Water Problems of the San Joaquin Valley,' by G. McM. ROSS, Stockton; 'The Sacramento River Project,' by V. S. McCLATCHY, chairman of the California State Reclamation Board, Sacramento; 'Los Angeles Harbor Project and Problems,' by HENRY HAWGOOD, consulting engineer, Los Angeles; 'Colorado River Control and Use of Its Flood Waters,' by J. B. LIPPINCOTT, consulting engineer, Los Angeles; 'The Economic Value of the Water Resources of California to Its Chief Port,' by C. E. GRUNSKY, consulting engineer, San Francisco. The following legislative committee was appointed: ROSCOE J. ANDERSON, Redding, chairman; ISIDOR JACOBS, San Francisco; R. M. GREEN, Oroville; A. J. HILL, Los Angeles; W. F. HOLT, Imperial; CHESTER H. ROWELL, Fresno; and C. H. WINDHAM, Long Beach. A committee on Investigation of Federal and State Projects was also appointed, composed as follows: C. T. LEEDS, chairman, Los Angeles; H. HAWGOOD, Los Angeles; V. S. McCOY, Oroville; RICHARD H. NORTON, Los Angeles; F. H. OLMSTED, Los Angeles; G. McM. ROSS, Stockton; P. M. STAFFORD, Madera; and THOMAS TABERT, Santa Ana.

## Commercial Paragraphs

The AUSTIN-WESTERN Co. has sold a ten-ton gas-propelled road-roller to the board of supervisors of Lassen county, California.

The city commissioners of Baker, Oregon, have purchased a flushing tank from the HODSON-FEENAUGHTY Co., of Portland, and 3½-ton Federal motor truck for use of the street cleaning department.

The LLEWELLYN IRON WORKS, Main and Redondo streets, Los Angeles, has been awarded the contract for the erection of the superstructure of the three steel radio stations at the naval reservation at San Diego, and for a similar station on the Hawaiian Islands.

The ELECTRIC RAILWAY & MANUFACTURERS' SUPPLY Co., 84 Second street, San Francisco, has been appointed agent jobber for the Westinghouse Electric & Manufacturing Co. for the portion of California north of 35th parallel of latitude and the portion of Nevada west of the 116th meridian of longitude.

## Catalogues Received

'The Tool-om-eter,' the NEW JERSEY METER Co., Plainfield, New Jersey, four-page description of the Company's devices for measuring the flow of compressed air in a pipe or hose. Illustrated.

'The Wendell Centrifugal Coal Drier,' 'Link-Belt Electric Hoist,' the LINK-BELT Co., Philadelphia, Chicago, Indianapolis; these four-page illustrated pamphlets give brief descriptions of the two machines.

'Brownhoist Locomotive Cranes,' Catalogue I, the BROWN HOISTING MACHINERY Co., Cleveland, Ohio, describes the cranes manufactured by the Company and gives a number of photographs of construction work on which they were employed. P. 72. Illustrated.

'Blaisdell Equipment,' the BLAISDELL MACHINERY Co., Bradford, Pennsylvania, describes the air and gas compressors manufactured by the Company, and gives a number of mathematical tables of value in the design of a compressor plant. The Company's telegraphic code is included. P. 126. Illustrated.

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